Englische Originalzitate PlasmaVersum Bd.1 (geordnet nach Nummer der Fußnote)

004: »The history of cosmic theories, in particular, may without exaggeration be called a history of collective obsessions and controlled schizophrenias; and the manner in which some of the most important individual discoveries were arrived at reminds one more of a sleepwalker's performance […].«

005: »Induction, analogy, hypotheses founded upon facts and rectified continually by new observations, a happy tact given by nature and strengthened by numerous comparisons of its indications with experience, such are the principal means for arriving at truth.«

008: »Quite generally, what is one discipline's output is another discipline's boundary condition or input.«

009: »The real Universe is more complicated. In almost any system that the human mind defines and selects as a target of study, processes occur that pertain to a whole spectrum of disciplines. […] consider several mutually interacting systems as components of one single, global ›supersystem‹.«

010: »To a large extent, plasma physics is a unifying element common to all parts of this supersystem.«

012: »We should remember that there was once a discipline called natural philosophy. Unfortunately, this discipline seems not to exist today. It has been renamed science, but science of today is in danger of losing much of the natural philosophy aspect.«

015: »They were aware that the symbols of mythology and the symbols of mathematical science were different aspects of the same, indivisible Reality. They did not live in a ›divided house of faith and reason‹; the two were interlocking, like ground-plan and elevation on an architect's drawing. It is a state of mind very difficult for twentieth-century man to imagine- or even to believe that it could ever have existed. It may help to remember though, that some of the greatest pre-Socratic sages formulated their philosophies in verse; the unitary source of inspiration of prophet, poet, and philosopher was still taken for granted.«

018: »To be sure, nothing expected was ever encountered; only the unexpected but readily recognizable from a standpoint of HEDP [High energy density plasma] in astrophysics and cosmology.«

019: »The fact that we have not been able to detect any matter in inter-nebular space does not necessarily exclude its existence, even in considerable quantity.«

020: »One simple illustration refers to the material population of the intergalactic spaces. Just because of the fact that no one has seriously interested himself in the contents of the vast spaces between the extra-galactic nebulae, even the experts had come to believe both in their sleeping and in their waking hours that intergalactic space is essentially empty except for the light quanta traversing it. […] When he hears theorists and observers alike state, that they do not believe in the existence of intergalactic matter, he takes this for what it is worth, an occultistic belief, completely unfounded in real knowledge.«

021: »At meter wavelengths and shorter, the radio sky is much like the optical night sky. There is a dark background with small sources sprinkled over it. The Milky Way shows up as a bright band across the background. I rather expected something similar at hectometer waves. However, the situation was completely different and quite unexpected. At 2085 kHz the sky is similar to the daytime optical sky. It has a high-intensity distribution with maximum intensity at the galactic poles. There are assorted low-intensity patches, like optical clouds, scattered along the Milky Way. These absorb the background radiation. The lowest intensity is at galactic center. These clouds are probably low-temperature plasma. Locating a bright object on a dark background is relatively easy. [...]
The background lies definitely outside the Milky Way, as shown by absorption patches. Also, assorted known radio sources such as Centaurus, Fornax, Pictor, etc., could be found. Accordingly, the background is at some very great distance. [...]
What is the source of radio waves, measured at 144 m, from the background? A reasonable guess is that intergalactic space is filled with free electrons and protons. About one pair per 100 cm^3 will be adequate. [...]
An intergalactic plasma can well explain a variety of disconnected observations and give us a new perspective about the universe surrounding us. We may be on the verge of a new Copernican revolution.«

025: »In ionized matter – plasma – which dominates the universe, electromagnetic forces cause the constituent particles to exhibit an exceedingly complicated collective behavior. Although each individual particle obeys well-known laws, the complexities of their interactions defy purely theoretical deductions and can be understood only if theory is closely guided by empirical knowledge.«

026: »Because of their strong interaction with electromagnetism, plasmas display a complexity in structure and motion that far exceeds that found in matter in the gaseous, liquid, or solid states.«

027: »Today it is recognized that 99.999% of all observable matter in the universe is in the plasma state.«

028: »It is estimated that as much as 99.9% of the universe is comprised of plasma.«

029: »The plasma state is the most abundant state of matter. It is thought that more than 99.9% of matter in the universe is in plasma.«

030: »How was it determined that 99% of the Universe is in a plasma state? Most of the gas in interstellar space is ionized (astronomers can tell by the wavelengths of light the gas absorbs and emits), and all of the gas in stars in ionized, that's where the 99% comes from.«

031: »According to the tenets of plasma cosmology, however, electromagnetism, not gravity, makes the universe what it is. The medium in which electromagnetic forces are played out is plasma, which is believed to constitute 99% of the universe.«

033: »While it is universally acknowledged that our Universe is a plasma universe, it seems to be far from fully realized that the physical understanding of this Universe depends critically on our understanding of matter in the plasma state.«

034: »There is no analogy to high-vacuum phenomena in cosmic physics. When considering electrical phenomena the interstellar space of our galaxy should not be compared with a ›vacuum‹ but with a highly ionized gas at a pressure of 100 atmospheres.«

039: »It turns out that a very low degree of ionization is sufficient for a gas to exhibit electromagnetic properties and behave as a plasma: a gas achieves an electrical conductivity of about half its possible maximum at about 0.1% ionization and had a conductivity nearly equal to that of a full ionized gas at about 1% ionization.«

040: »The degree of ionization in interplanetary space and in other cosmic plasmas may vary over a wide range, from fully ionized to degrees of ionization of only a fraction of a percent. Even weakly ionized plasma reacts strongly to electromagnetic fields since the ratio of the electromagnetic force to the gravitational force is 39 orders of magnitude. For example, although the solar photospheric plasma has a degree of ionization as low as 10^{-4}, the major part of the condensable components is still largely ionized. The ›neutral‹ hydrogen regions around galaxies are also plasmas, although the degree of ionization is only 10^{-4}. Most of our knowledge about electromagnetic waves in plasmas derives from laboratory plasma experiments where the gases used have a low degree of ionisation, 10^{-2} - 10^{-6}.«

054: And if the night sky on which we observe them is at a high latitude, outside this lecture hall […] we may also see in the sky an aurora, which is a cosmic plasma, reminding us of the time when our world was born out of plasma. Because in the beginning was the plasma.

059: »Another translation which is equally important is the translation between a magnetic field description and a current description of plasma phenomena. Space measurements of magnetic fields are relatively easy, whereas direct measurements of electric currents are very difficult, in many cases impossible. Hence, it is natural to present the results of space exploration (from spacecrafts and from astrophysical observations) with pictures of the magnetic field configuration.«

066: »Plasmas are prodigious producers of electromagnetic radiation.«

076: »In astrophysics, nonthermal (nonequilibrium) cosmic radio emission is, in a majority of cases, synchrotron radiation. This is true for general galactic radio emission, radio emission from the envelopes of supernovae, and radio emission from double radio galaxies and quasars (continuum spectra). Synchrotron radiation also appears at times as sporadic radio emission from the sun, as well as from Jupiter. In addition, optical synchrotron radiation is observed in some instances […]. Synchrotron radiation in the X ray region can also be expected in several cases, particularly from the Crab nebula.«

078: »There is a current layer in the front of the magnetopause which separates a region of very weak magnetic field in the solar wind from a much strong field (three times or more) between the front current and the magnetopause. This current layer is usually referred to as the ›bow shock‹. It transforms a large part of the solar wind kinetic energy into electromagnetic energy.«

082: »The discovery of these layers (the first one, the magnetopause, discovered by Cahill) appears to many as the most sensational of all space research discoveries (although Dungey (1961, 1964) had predicted them to some extent). It is

especially surprising that these current layers exhibit such a remarkable permanence, if not stability. The existence of such layers changes our views of the structure of space plasmas (FaItharnmar et al., 1978). As such layers are of course likely to exist also in regions where spacecraft have not yet made in situ measurements, we must drastically revise our views of the structure of space. The existence of such boundary layers leads to the conclusion that space everywhere (interstellar space and intergalactic space) has a cellular structure.«

085: »[...] plasmas often display a filamentary structure. This structure derives from the fact that plasma, because of its free electrons, is a good conductor of electricity, far exceeding the conducting properties of metals such as copper or gold. Wherever charged particles flow in a neutralizing medium, such as free electrons in a background of ions, the charged particle flow or current produces a ring of magnetic field around the current, pinching the current into filamentary strands of conducting currents.«

086: »It seems likely that electromagnetic constriction constitutes the most important effect in cosmic physics. […] Hence for the application to cosmic physics we ought to study the constriction due to magnetic effects. This is certainly a complicated phenomenon.«

089: »A Z pinch in its simplest form is a column of plasma in which current is driven in the axial (z) direction […] producing an azimuthally directed magnetic field that tends to confine the plasma. The response of the Z-pinch plasma to that applied current is at first glance quite simple but, upon more careful study, complex beyond belief. The entire Z-pinch phenomenon evolves rapidly into nonlinear hydrodynamic behavior. The atomic, ionization, and radiative physics that are inherent in Z-pinch implosions add yet another layer of complexity. There are few fields in physics like plasma physics in which a simple assembly of relatively common components gives results that are difficult to understand qualitatively let alone quantitatively.«

101: »Their discovery in the earth's magnetosphere in 1974 has resulted in a drastic change of our understanding of aurora dynamics, now attributed to the filamentation of Birkeland charged-particle sheets following the earth's dipole magnetic field lines into vortex current bundles.«

103: »A reason why Birkeland currents are particularly interesting is that, in the plasma forced to carry them, they cause a number of plasma physical processes to occur (waves, instabilities, fine structure formation). These in turn lead to consequences such as acceleration of charged particles, both positive and negative, and element separation (such as preferential ejection of oxygen ions). Both of these classes of phenomena should have a general astrophysical interest far beyond that of understanding the space environment of our own Earth.«

108: »For a rather wide range of parameters, a current through a partially ionized plasma is able to produce element separation.«

109: »Plasma convection in force-free magnetic fields as a mechanism for chemical separation in cosmical plasma. […] Filament formation and chemical separation are two important phenomena that are often observed in cosmical plasmas and illustrate the importance of inhomogeneity. […] The plasma convection associated with filamentary structures provides an effective means of selective transport. […] Under the influence of electric and magnetic fields the ionised component of the plasma drift inward from the surroundings toward the centre of the filament […]. This convection is a very efficient process for collecting material to form the filament. This is true, even of the process is slowed by collisions, because as long as the particles are charged they are forced to drift inwards. If the plasma is partially ionised – as in part of the solar atmosphere and many other cosmical plasmas – a temperature gradient will cause the radial transport to be different for elements with different ionisation potentials.
The most abundant elements of a cosmical plasma can be divided into groups of roughly equal ionisation potentials as follows: element (approximate ionisation potential): He, (24eV); H,O,N, (13 eV); C,S, (11 eV); Fe, Si, Mg, (8 eV).«

111: »The drift of ionized matter from the surroundings into the rope means that the rope acts as an ion pump, which evacuates the surroundings. Regions with extremely low densities can be produced in this way.«

113: »If an electrically conducting medium is present in a magnetic field, any hydrodynamic motion will give rise to induced electric fields which produce electric currents. Because of the magnetic field these currents will produce forces which change the state of motion. This coupling between mechanical and electromagnetic forces produces a type of wave motion, called magneto-hydrodynamic waves.«

115: »If the discharge current is considerable and somewhat irregularly distributed, the potentials of different points along the curve may fluctuate. […] Let us consider the effect of an increase of the potential at a certain point A of the curve. From this point we have a radial electric field in all directions. But in a magnetic field perpendicular to it, an electric field gives rise to a motion which is perpendicular to the magnetic field as well as to the electric field. Thus […] the radial electric field […] will produce a vortical motion. Consequently, a small space charge will cause a wave in the auroral arc. [...] This corresponds to the drapery-shaped arcs and draperies, well-known auroral forms.«

121: »A double layer (D L) is a local region in a plasma which can sustain a potential difference. Essentially it consists of two adjacent layers with equal and opposite net charge. The layer as a whole is globally neutral but has an internal electric field.«

123: »Probably the most interesting electric field observations of all are those made in the auroral acceleration region (Fig. 4.14). The first electric field measurements in this region were made with the S3-3 satellite. It led to two major discoveries: «electrostatic shocks" and multiple electric double layers.«

125: »Current limitation in plasmas due to formation of electric double layers is a fundamental phenomenon of great importance in various branches of plasma physics, e.g., space physics and solar physics as well as in technical applications.«

126: »Double layers produce beams of electrons and, on astrophysical scales, these beams are relativistic. […] the expected loss mechanism for the beam kinetic energy is synchrotron radiation.«

129: »In general a DL requires both free and reflected ion and electron components. The free particles carry current through the layer and lead to emerging beams of accelerated particles. […] Double layers are of interest in astrophysics as a direct means of accelerating particles (Alfven, 1981, 1986). They can sustain a local region of parallel electric field […].«

130: »There are good reasons to suppose that many of the explosive events observed in cosmic physics are produced by exploding double layers. Examples are magnetic substorms, solar flares, and similar phenomena in ›flare stars‹.«

133: »Because of the high anisotropy of any shock wave acceleration together with the complete lack of any laboratory evidence that shockwave/ charge particle acceleration actually exists, that field-aligned electric fields are the most plausible mechanism for producing cosmic rays.«

134: »The cosmical plasma physics of today [...] is to some extent the playground of theoreticians who have never seen a plasma in a laboratory. Many of them still believe in formulae which we know from laboratory experiments to be wrong.«

135: »The basic difference between the first and second approaches is to some extent illustrated by the terms ionized gas and plasma which, although in reality synonymous, convey different general notions. The first term gives an impression of a medium that is basically similar to a gas, especially the atmospheric gas we are most familiar with. In contrast to this, a plasma, particularly a fully ionized magnetized plasma, is a medium with basically different properties: Typically it is strongly inhomogeneous and consists of a network of filaments produced by line currents and surfaces of discontinuity. These are sometimes due to current sheaths and, sometimes, to electrostatic double layers.«

136: »Whereas it is true that all plasmas are ionized gases, it is not true that what astrophysicists in general mean by ›ionized gases‹ has much to do with plasmas. They use the concept ›ionized gases‹ in a very restricted sense to denote a hypothetical medium that does not possess the complex properties of most real cosmic plasmas.«

137: »In order to understand the phenomena in a certain plasma region, it is necessary to map not only the magnetic but also the electric field and the electric currents.«

138: »A number of plasma phenomena, like double layers, critical velocity, pinch effect and the properties of electric circuit are of decisive importance. The phenomena mentioned are well-known since decades (or even more than a century) but up to now they have systematically been neglected in cosmic physics.«

139: »The necessity for a threedimensional electromagnetic approach derives from the fact that the evolution of magnetized plasmas involves complex geometries, intense self-fields, nonlinearities, and explicit time dependence. Moreover, synchrotron radiation and double layers are discrete particle phenomena and cannot be studied using magnetofluid models of plasma.«

140: »We cannot possibly describe a double layer by a magnetic field related formalism. Double layers are observed at currents so low that the magnetic field they produce is negligible.«

141: »Again, it should be mentioned that there is no possibility of accounting for the energy of the particles as a result of ›magnetic merging‹ or of ›magnetic field-line reconnection‹, or any other mechanism which implies changing magnetic fields in the region of acceleration. In the region of the double layer, the magnetic field during the explosive transient phase is almost constant and cannot supply the required energy.«

143: »I think it is evident now that in certain respects the first approach to the physics of cosmical plasmas has been a failure. It turns out that in several important cases this approach has not given even a first approximation to truth but led into dead-end streets from which we now have to turn back. The reason for this is that several of the basic concepts on which the theories are founded, are not applicable to the condition prevailing in cosmos. They are ›generally accepted‹ by most theoreticians, they are developed with the most sophisticated mathematical methods and it is only the plasma itself which does not ›understand‹, how beautiful the theories are and absolutely refuses to obey them. It is now obvious that we have to start a second approach from widely different starting points.«

145: »Matter in the plasma state is characterized by a complexity that vastly exceeds that exhibited in the solid, liquid and gaseous states. In fact, the physical, and especially the electrodynamical, properties of plasma are still far from well understood. These properties are still subject to basic research, and many fundamental questions remain to be answered.«

146: »[...] Cosmical plasma physics outside the region accessible to spacecrafts necessarily must remain so speculative that one is tempted to question whether it is an appropriate field of serious science. The chance that any easy chair mechanism, however ingenious, should turn out to be correct is indeed very small. We know from many discouraging experiences that a basic property of a plasma seems to be that it always does something else than the theoreticians have expected it to do.«

147: »While it is thinkable that our ability to make in situ measurements can perhaps be extended to the nearest stars, most of the universe beyond a few parsecs will be beyond the reach of our spacecraft forever. From one's unaided view of the clear night sky, it is tantalizing to believe that the physics of the universe can be unfolded from the observable stars [...] or from the fuzzy ›nebula‹ such as the galaxy M31 [...]. Our experience in unfolding energetic events in our own solar system suggests otherwise. The inability to make in situ observations places a severe constraint on our ability to understand the universe, even when the full electromagnetic spectrum is available to us.«

148: »[...] Plasma has general patterns of behaviour which in important respects are the same in the laboratory and in the ionosphere-magnetosphere-heliosphere. We may expect that the general pattern is the same also in the more distant regions of space which still are unaccessible to in situ measurements.«

149: »In the realm of plasma physics, there appears to be no reason why known basic laws, formulated in the laboratory, should not hold just as well at the astrophysical and cosmological scale.«

152: »This prediction followed from the fact that volumewise, the universe is 99.999% matter in the plasma state. When the plasma is energetic, it is generally inhomogeneous with constituent parts in motion. Plasmas in relative motion are coupled by the currents they drive in each other and nonequilibrium plasma often consists of current-conducting filaments.«

155: »There is a strong presumption that this is a physically connected quintet, although this remains to be proved. […] If the galaxies are really arranged spatially in a chain, it seems unlikely that such a configuration could remain stable for a long time. It also seems unlikely that the configuration could be due to a chance orientation effect. […] The possibility that this system represents some transient stage in the formation or evolution of small groups of galaxies is intriguing.«

156: »First, we note that there is a systematic trend of redshift with position along the chain for the four galaxies A, C, D, and E. This clearly can be interpreted as a rotation.«

157: »The foregoing probability arguments lend support to, but do not prove, an intuitive belief that the configuration of galaxies in VV 172 is unlikely to be the result of chance superposition.«

159: »Attempts were made to find direct evidence of interaction that could be related to the discordant components. In VV, the extent and smoothness of the enveloping halo, especially in the vicinity of the discordant galaxy, was the strongest direct evidence for interaction. [...] In the absence of b as a physical member, the larger separation of components a-c compared to c-d and d-e makes it likely that some degree of indentation would be seen in the halo. Alternatively stated, the presence of component b as a physical member of VV is more compatible with the observed halo properties of great extent and uniformity.«

167: »Cold dark matter is a theory about the beginning of the formation of structure.«

171: »If you take a highly intelligent person and give them the best possible, elite education, then you will most likely wind up with an academic who is completely impervious to reality.«

173: »The most prominent and defining features of the cosmic web are the filaments. The most outstanding specimen in the local Universe is the Pisces-Perseus chain.«

174: »The whole picture resembles cells. One cell wall with surrounding cluster chains can be taken for a supercluster. All clusters of galaxies and most galaxies are located in superclusters. Neighboring superclusters are in contact and contain common elements.«

175: »Already in first studies of the 3-D distribution of galaxies in large areas of the sky it was noticed that galaxies and clusters of galaxies are not randomly clustered, but form long filaments and sheets. Filaments and sheets are arranged in superclusters, and the space between superclusters is almost void of galaxies and clusters of galaxies. Filaments form a more or less continuous network.«

176: »The supercluster contains a variety of substructures: clusters, sheets, and filaments. Its high density is further contrasted by the surrounding low-density voids both to the foreground and the background. […] Unless Pisces-Perseus is unlike most large-scale structures, galaxies occupy very specific volumes of the universe — thin, intersecting density enhancements that connect the major clusters.«

179: »On Megaparsec scales the matter and galaxy distribution is not uniform, but defines an intricate multi-scale inter-connected network which is known as the cosmic web. It represents the fundamental spatial organization of matter on scales of a few up to a hundred Megaparsec. […] It defines a complex spatial pattern of intricately connected structures, displaying a rich geometry with multiple morphologies and shapes. This complexity is considerably enhanced by its intrinsic multiscale nature, including objects over a considerable range of spatial scales and densities.«

180: »The Cosmic Web is one of the most striking examples of complex geometric patterns found in nature, and certainly the largest in terms of size.«

181: »It has long been known that galaxies are not spread evenly throughout the universe but instead are organized into larger structures stretching out to scales 100 Mpc. Large redshift surveys mapped this structure in three dimensions and showed that in addition to the conspicuous clusters of galaxies, there are also extended one-dimensional filaments and two-dimensional sheets.«

183: »One of the most compelling pieces of evidence for the existence of superclustersized Birkeland currents comes from the discovery of faint supercluster-scale radio emission at 326 MHz between the Coma cluster of galaxies and the Abell 1367 cluster. The radiation's synchrotron origin implies the existence of a large-scale intercluster magnetic field with an estimated strength of $0.3 – 0.6 \times 10^{-10}$ T (0.3 – 0.6 mG). For the linear dimension of the source, ∼1.5 Mpc, the current to produce a field of this magnitude is $\sim 0.5 \times 10^{19}$ A.«

185: »In the laboratory the width of a synchrotron-emitting filament is about a ten-thousandth of its length. If what astronomers perceive as a double radio galaxy is actually the cross section of interacting plasma filaments, then double radio galaxies – and ultimately all galaxies – should be part of filamentary structures stretching across 10.000 times 100.000 light-years, or a billion light years of space.«

186: »In cosmic plasma the perhaps most important constriction mechanism is the electromagnetic attraction between parallel currents. A manifestation of this mechanism is the pinch effect as first studied by Bennett (1934). Phenomena of this general type also exist on a cosmic scale and lead to a bunching of currents and magnetic fields to filaments. This bunching is usually accompanied by the accumulation of matter, and it may explain the observational fact that cosmic matter exhibits an abundance of filamentary structures.«

187: »The cosmic web is a direct result of two physical drivers, which are at the heart of the current paradigm of structure formation. The first is that the initial density field is a Gaussian random field, described by a power spectrum of density fluctuations (Adler 1981; Bardeen et al. 1986). The second is that these perturbations evolve entirely due to gravity (Peebles 1980). […] As borne out by a large array of N-body computer experiments of cosmic structure formation web-like patterns defined by prominent anisotropic filamentary and planar features — and with characteristic large underdense void regions — are the natural outcome of the gravitational cosmic structure formation process.«

188: »The evolution, structure and dynamics of the cosmic web are to a large extent dependent on the nature of dark matter and dark energy.«

189: »The Biot-Savart force varies as r^{-1} and thus dominates gravitational attraction which varies as r^{-2}. ›Great Attractors‹, often attributed to gravitational forces between ›missing masses‹ display Biot-Savart, not mass attraction, characteristics.«

192: »For plasmas there is a neutral force region where the filaments do not merge but rather start a rotational motion around each other to form a vortex–like geometry. In the laboratory, this is most often seen for the closest pairs of filaments but also for three and more filaments.«

194: »This emission requires a population of relativistic electrons and a magnetic field located in a filament between the two galaxy clusters.«

195: »We still don't know where this preexisting population [of electrons] comes from. They may have been ejected in the past by galaxies or by explosions of supernovae.«

196: »Radio bridges connecting pre-merging clusters are a recent discovery. So far, the cluster pairs A1758N-A1758S (at z = 0.279) and Abell 399-401 (at z = 0.07) are the only two cases where a bridge of radio emission between two clusters has been observed. The two systems show remarkable similarities.«

203: »Because of the higher mobility of the electrons, these diffuse more rapidly, so after some time there is [immediately outside the border] a region containing a surplus of electrons, whereas immediately inside the border there are more ions than electrons. Hence an electric field is produced which impedes the outward motion of the electrons and accelerates the ionic diffusion. [...] This type of diffusion is called ambipolar diffusion. It is a very important phenomenon in ordinary gaseous discharges.«

205: »Not only the morphology but the controlling dynamic elements, electric and magnetic fields, are the same in the laboratory as in the galactic phenomena. […] The astrophysical community, with the possible exception of Alfven, has largely ignored this hypothesis for the last 30 years.«

207: »The ease with which nature can take the electrical energy in the plasma gun, turn it into directed kinetic energy and momentum of the plasma, and then turn a large share of that energy into rotating energy of vortices suggests that most of the rotational motion in the universe (as well as in our solar system) is acquired by the dynamic effects of plasmas moving in, across, and with magnetic fields.«

209: »The only physical agent that seems to be capable of keeping the filaments together as coherent units is the magnetic field.«

214: »The spatial associations between HI and ILC emission peaks point to the existence of one or more processes occurring in interstellar space capable of generating weak continuum radiation observed by WMAP. The radiation appears to originate at the surfaces of dynamic and interacting HI structures.«

218: »Verschuur's mappings show that galactic foreground HI structure is not random but part of very long twisted filaments of cosmic scale. These form a Bplasma forest[through which any observation of the microwave background must be capable of penetrating. For example, an all-sky survey of high-frequency radio continuum emission from observations of the Wilkinson Microwave Anisotropy Probe (WMAP) spacecraft should have no relationship to galactic HI filaments. However, Verschuur finds just such a relationship that […] has far-reaching implications for the interpretation of WMAP data.«

219: »Simulations of a plasma universe indicate that its fields and currents can give rise to a cosmic microwave background, uniform in all directions. As laboratory experiments have shown, all filamentary plasmas generate microwaves. Simulations of the mechanisms that generate microwaves in the laboratory, when scaled up to galaxtic dimensions, generate microwave radiation at a temperature of 2,0 degrees above absolute zero, which compares favorably with the observed radiation at 2,78 degrees. […] the plasma filaments encompassing the billions of galaxies scattered through space could absorb and reemit such radiation repeatedly. The process would ultimately scramble the radiation into the uniform sea we now observe.«

220: »It is argued that where plasma cosmology fails is in explaining the existence of the microwave background. Plasma cosmologists disagree. The cosmic background radiation, they say, results when local fields and currents scatter microwave radiation from pervasive plasma sources-like radio galaxies and quasars just as a dense fog scatters a car's headlights.«

222: »Previous evidence has supported the idea that the IGM is not transparent to radio and microwave radiation, but scatters and isotropizes it. The principle evidence for this is in the decrease with distance of radio luminosity of galaxies for a constant IR luminosity. More recent evidence extends this relationship to 300 Mpc and yields a statistically significance of 8 sigma. Such a relationship can only be explained by an absorptive medium, which by Kirchoff's [sic] law must be responsible for the blackbody CBR emission.«

225: »Every so-called HI ›cloud‹ is found to be associated with a filament while the ›clouds‹ are usually found where the filaments show changes in the orientation of their axes, as if defining kinks in the filaments. This raised the interesting possibility that a ›cloud‹ of diffuse interstellar HI, defined by a localized enhancement of HI emission, might be a geometric illusion produced where a segment of filament twists into the line of sight.«

226: »Diffuse interstellar HI is clearly highly filamentary. In low-resolution surveys the pervasiveness of filaments may often be overlooked by labeling localized enhancements in HI brightness as clouds defined as nearly spherically symmetric, bound entities, rather than their being due to line-of-sight enhancements where filaments twist into the line-of-sight.«

229: »Essentially, the only alternative to this is to assume that GRBs are generated by electric discharges which can be called ›cosmic lightning‹.«

230: »[…] we discuss the possibility of particle acceleration in strong but short-lived electric fields emerging during episodic current disruptions in cosmic plasma pinches.«

231: »The current disruptions are reproducible and often very deep; for certain parameters the current is reduced to 10% of the value before the disruption.«

235: »Two maxima are clearly seen on the plot apparently implying that two types of GRB occur – short (t≤1:5 s) and long (t≥1:5 s). Qualitatively, this is in accordance with our model, in which the possibility for the formation of even three types of pinches Ð interstellar, disk-galactic, and halo-galactic (or metagalactic) Ð is envisaged. Probably, a GRB with a duration of 90 min and a maximum photon energy of 18 GeV […] should be related to the third type (see Fig. 5). Clearly, such quanta cannot have a ›temperature‹ origin in thermonuclear reactions on the surface of neutron stars, whereas the bremsstrahlung radiation of ultrarelativistic electrons seems to be capable of producing such quanta.«

237: »Case studies have shown that TGFs can be observed in association with positive Intra-Cloud (IC+) lightning, and several case studies have shown that TGFs are typically produced in the initial phase of lightning flashes during the upward propagation of leaders.«

241: »As a rule, each GRB consists of an irregular sequence of several microbursts, and this feature is difficult to interpret.«

244: »It is possible that dust grains play a role in producing the emission.«

249: »In terms of conventional plasma physics, the heteromac may be a result of strongly nonlinear kink mode in an originally straight plasma column, which is subjected to twisting of the spatially distributed (›diffused‹) electric current passing through the column.«

253: »It appears that the thickest innermost filaments, from few to several in number, constitute a thick trunk of the tree (figure 6, t = -450 ns). This trunk plays the role of the pinch's main body. The branches of the tree are produced by the loops of thickest filaments branched off the pinch's main body, that is, by the largest heteromacs. These branches are essentially nonaxi symmetric and are directed roughly perpendicular to Z-pinch's major axis. Sometimes they have the form of a roughly horizontal (i.e., radially directed) stick; sometimes they form a (horizontal) fractal plane, or the situation is intermediate/ transient between these two limiting cases.«

255: »Heteromacs, in space, are the coming together of adjacent field aligned currents known as Birkeland currents and their subsequent coiling into helices. […] During intense current bursts […] they are visible by the white-light synchrotron light they emit […] As the giga-amperages subside, the sharpness blurs, and they appear as a ›cloud‹ to the observer.«

256: »Dark filaments are the key elements of the circuit. They could be formed presumably by a plasma with the temperature falling in one of the minima of plasma emissivity (e.g., such minima are well-known in the temperature dependencies of radiation losses and emissivities of corona-like plasmas). The filaments seem to penetrate entire space.«

257: »The heteromac as an almost-closed magnetic configuration is statistically (i.e., in a large ensemble of heteromacs) much less visible to the Faraday rotation-based diagnostics, as compared to the diagnostics of a nonclosed magnetic configuration.«

259: »Thick enough (and, correspondingly, optically thick) filament works as a negative lense […] The negative lensing effects could contribute significantly to interpreting the gravitational lensing phenomena.«

269: »Magnetic dipole attraction of such nanoblocks may be a ›glue‹ essential for the buildup—already at the electric breakdown stage—of various long-lived skeletons of macroscopic size.«

273: »The skeleton is composed of hexagons assembled from the dipoles. The structure of the tubular straight skeleton,

whose wall is assembled from hexagons and whose cross section has also a hexagonal structure. In general case, it is possible to compose a skeleton from arbitrary polygons provided the magnetic charges on the tips of the blocks support the respective magnetic threading.«

275: »The observed skeletons have the structure much different from ideally self-similar structures: for instance, in the one of the most distinct TEM images (see Fig. 2 in [10]), the tubule of 70 nm in diameter with the cartwheel in the butt-end, the distinct central rod and radial bonds between the side-on cylinder and the central rod, is 140 nm long and has no hexagons in the tubule's wall. Another tubule composed of nanotubules, Fig. 5 in [11], is 30nm in diameter and also has, in its side wall, the straight blocks only and no hexagons. The bigger tubules of ~ 0.5 - 5 microns in diameter (Figs. 4 and 5 in [10]) also have no signs of ideal selfsimilarity. This illustrates the note in [6,7] that actually the construction material may have a broad distribution in geometric and mechanical parameters of tubules.«

286: »One of the new phenomena which were discovered from images of laboratory and cosmic plasma, were rectilinear dark filament structures with ends that can shine like ends of optical fibers. The wavelength region of the light emission corresponds to the temperature of the studied plasma. These coaxialtubular structures were named ›electric torch-like structures‹.«

288: »Local disruption of an electric circuit […] and the presence of the open end (in particular when the circuit has a dendritic structure) may self-illuminate the circuit to make it observable.«

292: »At extra-galactic length scales, the selfillumination of the skeletal network in its certain, critical points continues working but the dramatic decrease, with increasing length scales, of the average density of hot, radiating baryonic matter leads to observability of exclusively dim dotted imprints of skeletons, like e.g. mysterious dotted images of arcs, circles, and ellipses.«

299: »Carbon is found in space in all its allotropic forms: diamond, graphite, and fullerene. Astronomical observations in the last decade have shown that carbonaceous compounds (gaseous molecules and solids) are ubiquitous in our own as well as in distant galaxies […] Large carbon abundances are already extrapolated from observations of the strong C[II] and CO lines in the hosts of the most distant quasars.«

306: »As fullerenes and CNTs are intimately related (e.g. nanotubes are often known as cylindrical fullerenes), the ubiquitous detection of fullerenes in various astrophysical environments (see Zhang & Kwok 2013), together with the remarkable stability of CNTs against intense radiation, reinforces the idea that CNTs may also be widespread in the ISM. Although the formation processes of fullerenes and CNTs in space are still unclear to date, they may both be related to PAHs that are ubiquitously seen in a wide variety of astrophysical regions.«

309: »The assembling processes may occur at different length scales and involve available tubules of proper generation(s). The laboratory electric discharges, which are capable of producing the CNTs, may form both the longlived
filaments and long-lived networks of these filaments. For instance, the ~2 cm long and ~ 1 mm thick straight filament directed almost transverse to electric current in the Z-pinch (see Fig. 1 in [7]), was suggested to have a tubular skeleton of third generation (i.e. the values F12 ~ F23 ~ 10^3 were accepted). Correspondingly, the minimal number (and mass) of carbon atoms needed to assemble such a skeleton was estimated (see Eq. (1) for Ag ~ 30) to be as small as ~ 10^{15} atoms (~ 10^{-8} g).«

310: »The microsolid skeletons were suggested to be self-protected from an ambient high-temperature plasma by thin vacuum channels self-consistently sustained around the skeletons by the pressure of high-frequency (HF) electromagnetic waves, thanks to the skeleton-induced conversion of a small part of the incoming slow, quasi-static magnetic field (poloidal, in tokamaks, or azimuthal, in Z-pinches) into HF waves.«

312: »There were voids around the filaments in the dusty plasma structure. The gaps around the filaments in the dusty structure were substantial, 0.3 – 0.4 mm in size.«

317: »Electric dipole emission from rapidly spinning polycyclic aromatic hydrocarbons (PAHs) is widely believed to be an origin of anomalous microwave emission.«

318: »At cosmological scale the temperature of the overwhelming part of such a skeleton, i.e. excluding its critical, burning points, should be equal to that of cosmic microwave background radiation (CMBR).«

320: »Already a first set of pioneering observations (e.g., Ness, 1969) discovered that matter and electromagnetic fields in space have a complex structure, which was largely unpredicted. Terrestrial and, particularly, spacecraft observations of solar plasmas and fields point in the same direction. In fact, our present picture of the plasma and the electromagnetic fields in space throughout the solar

system (and beyond) is that of an extremely complex medium with spatial and temporal variations on large ranges of scales. The wealth of dynamical phenomena observed in space plasmas has steadily increased as more and more refined observational techniques have become available, and it can be expected that important processes still await their detection.«

323: »Since early-type spirals, Sa and Sba, resemble lenticular nebulae (E7) in many respects, the complete sequence of regular nebulae may be represented by a diagram shaped like the letter Y, or, since the spiral series are roughly parallel, like a tuning fork. Elliptical nebulae form the stem, with globular objects (E0) at the base and lenticular forms (E7) just below the junction. Normal and barred spirals lie along the two arms, and between the arms a few spirals of mixed types are found. […] The junction may be represented by the more or less hypothetical class S0 – a very important stage in all theories of nebular evolution.«

326: »In the plasma universe model, spiral galaxies form from the interaction of current-carrying filaments at regions where electric fields exist.«

327: »A universal characteristic of current-conducting plasma is that it pinches along the flow because of the inward pressure of its selfmagnetic field. It is at the pinch points in the cosmic flux where bodies of gravitationally significant mass, galaxies consisting of 10^9 - 10^{10} stars, coalesce.«

328: »Where pairs of these spaghettilike structures interact, the particles gain kinetic energy and at narrow pinch regions produce the entire range of galaxy types as well as the full spectrum of electromagnetic radiation.«

332: »The converging magnetic-field lines continue to compress intergalactic plasma into two narrow channels formed on either side of the elliptical sump. […] It is noteworthy that the incoming plasma closely resembles the closing of two giant cymbals as is often the case for peculiar galaxies such as NGC 5128 and Cyg A, located between giant radio lobes, that possess ›dust lanes‹ at their midsection.«

335: »The radiation produced from the two nearest plasma filaments in interaction replicates both the isophotal and power spectra from double radio galaxies.«

336: »The double radio sources constitute one of the most puzzling problems in astrophysics.«

340: »Many excellent reviews of double radio sources are available in the literature, as are a number of models of sources. However, regardless of whatever ingredients are postulated as necessary in models used to «explain" their existence, what is observed from any radio source is synchrotron radiation, that requires only relativistic electrons in the presence of a magnetic field.«

343: »The effect of the ›colliding‹ magnetic fields is to produce an isobaric sump with elliptical cross section at the separatrix between parallel currents.«

345: »Ellipticals are most often found midway between the extended radio components of double radio galaxies and radioquasars. […] E galaxies are found most frequently in regions characterized by high galaxy density. Diffuse elliptical galaxies are also found midway between the synchrotron emitting galactic simulation filaments.«

348: »Experimental data concerning the diamagnetism of ionized gases are scarce. Certainly since the time of Faraday it has been known that flames are diamagnetic. The repulsion of a flame by a magnet was studied a great deal during the nineteenth century, but quantitative results are lacking. No recent measurements seem to exist : the field is as completely out of fashion. Although the discharge plasmas have been studied much more than flames, there seems to exist only one measurement of the diamagnetism of a plasma. This is made by Steenbeck (1936).«

350: »Classical plasmas in thermodynamic equilibrium should be neither para- nor diamagnetic due to the action of the Lorentz force. Magnetic confinement, however, is based on the observed diamagnetism of laboratory plasmas. The apparent paradox is investigated on the basis of the resistive magnetohydrodynamic equations. It is found that [...] these equations do not permit a solution, i. e. the paradox cannot be resolved.«

352: »A central object, often an elliptically shaped ›optical component‹, is observed in a majority of radio galaxies. This also occurs in the simulation and is determined both by the strength of the pinch field Bo and the thermokinetic pressure distribution within the plasma. The magnetic field contours, that were initially concentric rings about each column, travel toward the geometric center and form a magnetic centroid (sump) as the axial current increases. As this centroid evolves, the field isobars confine and sweep escaped column particles, as well as more tenuous intergalactic plasma, toward an elliptically shaped central region.«

354: »At T - 100, the elliptical sump extends some 50 kpc and can balance the thermokinetic pressure of a 10^4-m^{-3} 6-

keV plasma. At T = 255, the spatial extent of this isobar has been reduced to ~20 kpc.«

356: »This dynamic plasma concentrates itself into clockwise and counterclockwise rotating vortices (electric motors) each one of which is a potential homopolar generator which generates an EMF between its center and its periphery.«

362: »The full resolution map […] shows an intriguing morphology. A linear feature consisting of three discreet blobs […] is surrounded by an ellipsoidal distribution of emission. […] The linear feature is essentially along the minor axis of this ellipsoidal distribution of faint emission. The morphology is highly suggestive of a torus of emission in the plane of the galaxy and a linear feature perpendicular to it.«

365: »In S0 galaxies, gas counter-rotating across a wide range of radii has been already observed in NGC4546, while in NGC4550 ~50% of the stars are counter-rotating. In spiral galaxies, the only case of gas-rotation known is in the ›black eye‹ galaxy NGC 4826, which shows only a region of partial counter-rotation. There, the inner gas is co-rotating and only an outer HI ring is in counter-rotation. In NGC 7217, another spiral galaxy, the gas is co-rotating with most of the stars, but about 20-30% of the stars are counter-rotating.«

367: »[…] we identify […] an inner disk spanning 0.5 ungefähr größer r ungefähr kleiner 1.2 pc; and an outer disk extending to r ~ 7pc. The two disks counter-rotate […]. The outer disk of the parsec-scale molecular torus also counter-rotates with respect to the molecular ring at 100 pc scales.«

368: »Conservation of angular momentum precludes the formation of counter-rotating disks out of a single epoch of accreting gas, and, to our knowledge, accretion disk warping mechanisms cannot induce counter-rotation. It seems likely that the counter-rotating outer disk formed from gas that has been more recently introduced to the >1 pc-scale environment, perhaps from an errant cloud falling out of the host galaxy or a captured satellite dwarf galaxy.«

373: »Both solutions (closed-form and Euler) demonstrate repeated reversals in the directions of both the axial and the azimuthal magnetic field components with increasing radial distance. This implies the existence of a discrete set of virtual concentric cylindrical surfaces (see Figure 3). These surfaces are centered on the z-axis of the field-aligned current. At these discrete radial values, the axial field component, Bz is zero-valued and the azimuthal magnetic component, B, is at alternatingly clockwise and counter-clockwise maxima.«

374: »Unlike spirals, elliptical galaxies have a very small rotation rate (with rotation velocity of about 20 km s^{-1} as compared to 200 km s^{-1} in a typical spiral galaxy).«

376: »Elliptical (E) galaxies, as distinct from peculiars, irregulars, and spirals, are characterized by a very smooth texture, a bright nucleus, and a tenuous outer envelope of large extent (sensitive photographic plates show that the visible envelope may be 20 times the diameter of the nucleus).«

377: »This dynamic plasma concentrates itself into clockwise and counterclockwise rotating vortices (electric motors) each one of which is a potential homopolar generator which generates an EMF between its center and its periphery.«

381: »Somewhere within a globular nebula there will exist a photosphere and chromosphere, the conditions of the former being apparently similar to those of the sun's photosphere, and the light from which we receive diffused by the surrounding tenuous atmosphere.«

383: »The junction may be represented by the more or less hypothetical class S0 – a very important stage in all theories of nebular evolution. [...] At present, the suggestion of cataclysmic action at this critical point in the evolutional development of nebulae is rather pronounced.«

384: »The condition for the occurence of a flash is not that the breakdown potential be attained over the whole intervening space, but that a concentration of field should occur of sufficient intensity to initiate what may be called a ›self-propagating‹ discharge [...]. One characteristic of the first leader stroke which is nearly always observed is its discontinuous or ›dart‹-like appearance, which in my opinion has not so far been satisfactorily accounted for. The explanation now proposed is that the ›darts‹ represents the sudden transition of newly formed portions of the advancing streamer from glow to arc conditions. [...] The conditions for the occurence of a spark in a non-homogeneous field would thus appear to be that the current in the brush discharge from an electrode should be sufficient to cause glow – arc transition to occur, after which the leader progresses [...].«

387: »One of the more interesting features of double radio sources is their ›hot spots‹, usually located diametrically opposite an imaginary line connecting the center with the two radiation lobes. In the simulation these mark the location of the intense, synchrotron emitting, axial currents.«

399: »Peak current phase of a galactic discharge should last for probably millions of years.«

400: »A galactic magnetic field of the order Bc = 10^{-9} – 10^{-1} associated with a galactic dimension of 10^{20} – 10^{21} m suggests the galactic current be of the order IG = 10^{17} – 10^{19} A.«

402: »We present radio emission, polarization, and Faraday rotation maps of the radio jet of the galaxy 3C 303. From this data we derive the magnetoplasma and electrodynamic parameters of this 50 kpc long jet. For one component of this jet we obtain for the first time a direct determination of a galactic-scale electric current, and its direction − positive away from the AGN. Our analysis strongly supports a model where the jet energy flow is mainly electromagnetic.«

403: »The associated toroidal magnetic field is responsible for collimating the jet. An equal but opposite «return current" flows inward (or outward) at much larger distances from the jet axis.«

404: »Within 0.5 kpc of the jet axis there is a net flow of negative charge toward the AGN core.«

405: »These remarkably collimated jets can be considered as giant electro-magnetic circuits − on multi-kpc scales in intergalactic space. The energetics and the structure of these jets also make them capable, in principle, of accelerating cosmic rays up to ∼10^{20} eV.«

412: »The induction field across the channel is variable, causing the preconfined plasma to brighten or fade. […] Comparison of the integrated magnitude of the jet with previous independent measurements over the period 1934-1980 suggests that the jet is variable and has been fading more or less uniformly by about 0.8 mag per decade between 1964 and 1980. […] Comparisons of isophotes taken in 1964 and 1979 show no obvious differences in overall shape, apart from effects of variation and noise. This indicates that the fading has affected the whole channel more or less uniformly since 1964, i.e., the knots (i.e., filaments or vortices) have not been seen to move. However, between 1934 and 1956, knots A and B became significantly brighter than C.«

415: »The jet of M87 has the remarkable characteristic of showing several bright knots along its path, from parsec to kiloparsec scales. Since early studies, these knots have been proposed to actually trace filamentary structures […]. The unprecedented high angular resolution and high-sensitivity images obtained in this work allowed us to clearly resolve, for the first time, the morphology of a large part of the M87 jet into a double-helix structure […]. Thus, we confirm that the knots in this object are simply the locations where the two filaments cross each other.«

417: »When radio galaxies were discovered five years after the initiation of the discharge theory, it was immediately realized that they must be those galaxies in which the discharges are in progress, so that they must be either of type S0 or of late E types around E7.«

418: »94% of the radio galaxies within z = 0.03 are of Hubble type E/S0.«

419: »In the late 1970s, plasma simulations of the interacting plasma filaments suggested a scenario that double radio galaxies and quasars were embryonic precursors of galaxies.«

420: »Our conclusion implies an almost complete unification of radio galaxies and quasars: nearly all FR II lobes are powered (or have been powered) by jets from quasars.«

421: »Whenever the attractive force between simulation columns causes their separation to be reduced to a distance such that the repulsive force starts to become comparable to the attractive force, a burst in the radiation occurs.«

422: »Two interacting filaments will mutually attract until the magnitude of the short range repulsive force becomes comparable to the longrange attractive force. It is at this time that the simulations typically show an emissive burst of synchrotron radiation. The emission mechanism is not yet well understood, but may be related to impulsive magnetic forces impressed upon the electrons due to the changing magnetic-field topology during the coalesence phase of two interacting filaments (Fig. 2). The effects may be likened to that of impulsive solar microwave bursts that are believed to be produced by the gyrosynchrotron radiation of electrons accelerated in solar flares.«

425: »Powerful jets are a very common feature in radio quasars.«

426: »This variety of source represents a later stage in temporal evolution and is accompanied by somewhat richer isophotal patterns because of the action of the inductive field on the confined plasma.«

429: »Where were the ›naked eye phases‹ of galactic discharges? There ought to have been radio galaxies radiating an inordinate amount of energy analogous to these naked eye phases of novae, but no one had reported them prior to the discovery of quasars.«

430: »This phase of a lightning current wave lasts for m sec or tens of m sec of a solar flare for minutes and of a nova for days. In view of the similarity between the geometry of the nova and galactic outbursts we may assume that the peak current phase will last for similar proportions of the total life of the discharge in both cases. This leads to an estimate of the duration of the quasar phase of 10^4 to 10^5 years.«

432: »Hubble himself wrote that there is evidence of the occurrence of some cataclysmic action at SO. The theory provides this in the form of electrical discharges at 500,000,000°K which propagate with a velocity of 2500 miles/sec for a period of 10 - 100 million years! If you can imagine anything more cataclysmic than that...!«

435: »The difference was stunning and unprecedented. The hydrogen-alpha emission dropped by a factor of 50 in less than twelve years, and the quasar now looks like a normal galaxy.«

437: »Die unterliegenden oder ›Wirts‹- Galaxien von radioleisen Quasaren scheinen Spiralgalaxien zu sein, wohingegen die ›Wirte‹ von radiolauten Quasaren wahrscheinlich elliptische Galaxien sind.«
- K. I. Kellermann et al., Radio Galaxies and Quasars, in G. L. Verschuur & K. I. Kellerman (Hrsg.), Galactic and Extragalactic Radio Astronomy 2nd Edition (1988)*

438: »Most QSOs, irrespective of their radio power, are now found to be hosted by elliptical galaxies. This is consistent with the lack of luminosity differences between the two QSO classes (the lower-luminosity Seyferts are generally found in spiral galaxies), but leaves open the issue of why and how radio-loud quasars can produce the powerful, large-scale radio emission, while radio-quiet quasars cannot.«

440: »Whether or not an observer can see synchrotron radiation depends on his orientation with respect to the polarity of the electric field. A positive value for Ez accelerates electrons in the −z direction, which is also the direction of the gain pattern equation. An observer in the +z direction, or out of the gain pattern, would observe radiation only from the thermal plasma, which may be the case for some radio quiet quasars.«

441: »Blazars, including flat-spectrum radio quasars (FSRQs) and BL Lacertae objects (BL Lacs), are radio-loud active galactic nuclei (AGNs) observed with their relativistic jet axis along the line of sight.«

442: »Radio waves traveling through an inhomogeneous plasma may be modulated by scattering or lensing phenomena. This may lead to variations in the observed properties of compact sources, such as flat-spectrum radio AGNs.«

444: »While the large-scale lobes of radio galaxies are believed to remain steady over megayear to gigayear timescales, intrinsic radio variability on human timescales (days to years) is common among AGNs with compact (<1 kpc) jets such as blazars, unbeamed radio quasars/galaxies with young jets, the cores of FR I/FR II radio galaxies, and low-luminosity AGNs. […] the physics of the intrinsic variability of compact AGN jets remains an unsolved problem […].«

446: »Broadly, the relative numbers of fading versus obscured AGN […] suggests that these AGN are luminous in episodes lasting 0.2 – 2 x 10^5 years, probably with many such episodes over much longer lifetimes.«

452: »The analysis presented in the preceding sections clearly shows the existence of a highly significant excess of strong X-ray sources around the analyzed Seyfert galaxies. Since the Seyfert sample has a high degree of completeness this is a very robust result.«

454: »There is a noticeable tendency in the excess sources discovered in the present analysis of being paired across the Seyferts.«

458: »It is interesting to note that in the N galaxies the same subgroups may be recognized as in the quasars. The N galaxies are frequently regarded as transition stages of intermediate optical activity in the nucleus between ordinary galaxies and quasars. If so, this suggests a picture in which the optical activity of the nucleus (and the related radio emission with flat spectrum) is to some extent uncorrelated with the radio component with a steep spectrum. Giant ellipticals, radio galaxies, N galaxies with steep spectra, and Qa would be all basically the same objects.«

461: »These results are all explained if the AGN in IC 2497 was a QSO until 105 years before our current view of it, and we see Hanny's Voorwerp as an ionization echo […].«

463: »The structure of spiral galaxies plays an integral role in understanding galactic dynamics and evolution; however, the precise nature of spiral arms still remains uncertain.«

464: »In the normal spiral, the two arms emerge smoothly from opposite segments of the periphery of a nuclear region resembling a lenticular nebula.«

465: »At the beginning of the sequence, the normal spiral exhibits a bright, semistellar nucleus and a relatively large nuclear region of unresolved nebulosity which closely resembles a lenticular (E7) nebula. The arms which emerge from the periphery are also unresolved and are closely coiled. As the sequence progresses, the arms increase in bulk at the expense of the nuclear region, unwinding as they grow, until in the end they are widely open and the nucleus is inconspicuous.«

466: »The neutralizing electrical discharges will be initiated in and confined to this plane, while lateral corona discharges will gradually neutralize the rest of the field.«

468: »In two reports published by the Electrical Research Association in 1955 and 1958 Dr. C. E. R. Bruce showed that the electrification of dust in cosmic atmospheres, and the breakdown of the resulting electric fields in electrical discharges, would account for the data of astrophysics in general and the radiation from and characteristics of radio galaxies in particular. It is noteworthy that the association of the surprisingly intense radiation from quasars with dust was confirmed soon after their discovery, thus confirming Dr Bruce's prediction made eight years earlier. […] The novelty of many of these theoretical predictions makes their subsequent confirmation by observations all the more cogent.«

469: »Where gas collects grains collect.«

470: »We detect dust emission in 24% of the ellipticals and 62% of the S0s. The mean temperature of the dust is 23.9 ± 0.8 K, warmer than that found for late-type galaxies in the Virgo Cluster. […] The average dust-to-stellar-mass ratio for the early-type sample is fifty times lower, with larger dispersion, than the spiral galaxies […]. We show that the sizes of the dust sources in S0s are much smaller than those in early-type spirals. These results suggest that the disks in S0s contain much less dust (and presumably gas) than the disks of early-type spirals.«

472: »The arms of the spiral galaxies are formed by the locally longest heteromacs subject to centrifugal force. Sometimes the arms are interconnected and form a complicated bunch of loops with a common node in the central part. In the case of more compact and stiff formations the longest, ›magnetic needle‹ heteromacs retain their almost rectilinear form.«

475: »The nebular arms are not seen in process of formation -- apart from the indications afforded by the existence of regions of bright line spectra, which betoken the progress of the discharge -- since the latter takes place largely well within the surrounding atmosphere, so that, when condensation has proceeded far enough for the arms to become visible, they have for a long time been completely formed, and become visible as a whole. Another of the major difficulties of existing theories would thus seem to disappear.«

478: »Hubble's type SBa has already been discussed in Section (4.1.3). They are galaxies in which the discharges remained straight throughout the whole process of electrical breakdown(2.44). Types SBb and SBc are those in which the discharges departed from the radial direction sooner or later(2.45).«

479: »The atmospheric electric field is built up during stages E0 to E7; breakdown occurs at around Type S0 when the discharge channels form the spiral or barred spiral arms. We have seen that in a large proportion of the analogous stellar outbursts the discharges remain straight. In galaxies this is less common, though barred spirals, those in which the two discharges have remained straight for an appreciable proportion of their life, are about as common as spirals. If one discharge is deflected from the radial direction by a random aggregation of space charge to one side or the other ahead of it, then the change in the electrostatic field at the advancing tip of the other discharge will be such as to make it turn off in the other direction and so spiralling of both discharges is initiated.«

482: »Precise measurements of the velocities of stars and gases in spiral galaxies make clear that the action of the galaxy on its stars and the gas estimated according to the classical gravitation theory cannot account for the measured velocities […] characterizes spirals as rigidly rotating, long-lived patterns. Thus, we can consider that in principle, stars and gas in spiral galaxies do not follow a rotational motion as described in classical gravitational theory, so they must obey other considerations to satisfy the observations.«

483: »The plasma crosses the magnetic field in a train of paired oppositely rotating diamagnetic vortices which are rotating like rigid (or rubber, no shear) bodies, much as a smoke ring or a pair of tornadoes moves through the atmosphere. […] These paired rotating diamagnetic plasma vortices are force-free (each one in its own rotating coordinate frame of reference) and each one is a minimum-free-energy construction because it rotates like a rigid body.«

486: »One of his main conclusions was the dependence of color on morphological type. Objects of different morphological classes show clear differences in their optical colors as measured by the color indices (U-B) and (B-V). Figure 5 shows the well-established trend between morphology and mean color. The E and S0 galaxies are clearly redder than their spiral counterparts, and the trend from redder to bluer is nearly monotonic.«

488: »Just as many B-type stars are reddened by the early stages of condensation of the matter neutralized by the nova discharge, so the colour excess of the nebulae, which also denotes the existence of absorbing matter at the corresponding stage on the nebular scale, is a maximum for Type Sa, and gradually decreases with advance in nebular type, until, when Sc is reached, condensation into stars is far advanced, and the colour excess has practically disappeared.«

491: »A surprising number of objects with R – K ≳ 6 have been identified in the vicinity of high-redshift radio galaxies and quasars.«

492: »A steep decrease in the presence of dust from Sb to Sbc-Sc types appears to produce the grand spiral design of the Sc galaxies.«

493: »[…] have a considerable effect on the disposition of gas and dust in the nebula. This will be collected into the discharge channels -- the spiral arms -- by the magnetic pinch effect, a deduction which has been in fact amply confirmed by various observations, optical and radio. There, in gas of greatly increased density, a second population of younger smaller stars will be formed relatively quickly.«

494: »The spiral arms of galaxies – or barred spiral or irregular arms – might be seen as the tangible relics of former discharges, now extinguished. The heavy elements identified in interstellar space in our own Galaxy might have been formed in situ at the high temperatures generated by the discharges, this obviating the need for there to have been previous generations of stars to make the elements – and methods of returning them, when made, to the interstellar medium.«

495: »Lightning and thunderclouds are natural particle accelerators. Avalanches of relativistic runaway electrons, which develop in electric fields within thunderclouds, emit bremsstrahlung γ-rays. […] The energy of the γ-rays is sufficiently high that they can trigger atmospheric photonuclear reactions that produce neutrons and eventually positrons […].«

496: »The concept of collective nuclear interactions that suggests a nucleosynthesis mechanism occurring on a very short time scale. According to this concept, collective nuclear interactions may be triggered by simultaneous acceleration of all particles in the system. […] In this case contrary to pair collisions the strong interactions will be engaged not just between two reacting nuclei but throughout large ensembles of nuclei, which will form heavy nuclear clusters as a result of system self-organization. […] Unlike pair-collision nuclear reactions that are characterized by specific nuclear products, the nuclear transmutation process driven by the collective interactions produces stable isotopes of virtually every element in the periodic table. […] Coherent acceleration, however, can be achieved by an action of a long range force, which can be either gravitational or electromagnetic force. […] The electromagnetic force can also create an environment for coherent acceleration of ions. A radiative collapse of z-pinch is one of the mechanisms that could serve this goal.«

497: »The older stars of Population II are those formed from the primordial gas of the original galactic atmosphere contemporaneously with the building up of the electric field in the remainder of the gas. They are unaffected by the discharges when they occur. The effect of the latter is to aggregate much of the remaining gas and dust on to the spiral arms. In these regions of considerably increased density a second population of younger stars is formed relatively quickly, Population I.«

498: »In the first place the gas which goes to the formation of Population I stars has been subjected to ›thermonuclear‹ discharge temperatures of around 5 x 10^8 °K for a period of the order of 107 years and its constitution must have been affected thereby. They should, therefore, contain a higher proportion of heavy atoms than do Population II stars despite the latter being by far the older. This difference is in fact observed: the heavy atom content of Population I stars is about 3%; that of Population II stars is only about 0.3%.«

499: »Small galaxies will evolve faster than will large galaxies, so that we should expect that small galaxies will pass relatively quickly along the evolutionary path from left to right (Fig.9) leaving the large galaxies behind among the E types. This expectation has been found to be fulfilled in recent years.«

502: »At very late times the pattern is almost isotropic and the identity of the two separate radiating lobes is lost.«

512: »Dwarf irregular galaxies can be considered extreme late-type spirals.«

513: »The discharges will be governed by random accumulations of space charge and will be quite irregular. Apart from their shape they should otherwise be similar to those in spiral galaxies.«

514: »Many irregulars are satellites of bright galaxies or at least of a small group of galaxies as in the Local Group.«

519: »Observations provide growing evidence that ring galaxies are more complicated and their structure cannot be completely explained by the collision picture. For example, the masses of the companions of the Cartwheel estimated by Higdon (1996) do not exceed 6% of the mass of the target galaxy. Such low-mass companions cannot trigger significant density enhancement in the disk of the galaxy under study (Tsuchiya et al., 1998).
Also, if ring galaxies were always formed through interactions between galaxies, we would expect them to be more common in the central regions of rich galaxy clusters, but this effect does not seem to be observed.«

531: »He found that the surface density of satellites in polar sectors of a spiral galaxy is larger than in equatorial sectors at corresponding radial intervals. This result is present at the 4-sigma level of statistical significance.«

532: »In the case of spiral galaxies with an edgewise orientation, the physical satellites have a peculiar distribution; most of them are found along the elongation of the minor axis, and they thus seem to favor high local latitudes. [...] The results favor the hypothesis that the satellites are produced by matter ejected from the nuclear regions of the spiral systems.«

534: »It has been known for a long time that the satellite galaxies of the Milky Way […] are distributed in a highly inclined disc of satellites (DoS). We have extended the previous studies on the DoS by analysing for the first time the orientations of streams of stars and gas, and the distributions of globular clusters within the halo of the MW. […] The MW thus is surrounded by a vast polar structure (VPOS) of subsystems (satellite galaxies, globular clusters and streams), spreading from Galactocentric distances as small as 10 kpc out to 250 kpc.«

536: »In laboratory models a rotating 'galaxy' generates two magnetic fields: one toroidal – an enormous ring around the galaxy in the galactic plane – and the other vertical, looping out of the galactic center above and below the plane of the galaxy. The two fields appear even if no magnetic field is initially present.«

537: »A catastrophic failure of the standard cosmological model.«

538: »The Milky Way and Andromeda galaxy are each surrounded by a thin plane of satellite galaxies that may be corotating. Cosmological simulations predict that most satellite galaxy systems are close to isotropic with random motions, so those two well-studied systems are often interpreted as rare statistical outliers.
We test this assumption using the kinematics of satellite galaxies around the CentaurusA galaxy. Our statistical analysis reveals evidence for corotation in a narrow plane: of the 16 CentaurusA's satellites with kinematic data, 14 follow a coherent velocity pattern aligned with the long axis of their spatial distribution. […] Corotating satellite systems may be common in the Universe.«

541: »This similarity of the stellar contents of arms and background, respectively, in both irregular and spiral galaxies, is highly significant from the point of view of the nature of the evolutionary processes involved. For it does indicate that both types have been formed by the same process, as the discharge theory suggests, and therefore rules out rotation as the prime cause, which has been the basis of most attempts hitherto made to explain the origin of the spiral arms.«

542: »Their existence would seem entirely to preclude rotation as the root cause of the arm formation, though it is the basis of all other theories.«

543: »A spiral galaxy combines the properties of irregular and elliptical nebulae. The flattened spiral arms are populated by the same objects that characterize irregular systems -- dust, gas and blue super giants. The spiral structure is imbedded in, and rotates within, a structureless sub-stratum that resembles an elliptical galaxy in general features and, in particular, in the objects that populate it.«

545: »We report the discovery of Seyfert-2 galaxies in SDSS-DR8 with galaxy-wide, ultra-luminous narrow-line regions (NLRs) at redshifts $z = 0.2 - 0.6$. […] these «Green Beans" (GBs) are amongst the rarest objects in the Universe. We are witnessing an exceptional and/or short-lived phenomenon in the life cycle of AGN. […] the NLRs reflect earlier, very active quasar states that have strongly subsided in less than a galaxies' light crossing time. These light echos, or ionization echos, are about 100 times more luminous than any other such echo known to date.«

547: »Balls of hot plasma escape at sudden bends in discharges. The bends constitute holes in the magnetic field of the discharge through which the gas compressed by the field can escape. These balls have been photographed in lightning and laboratory discharges.«

550: »The self-illumination of skeletal structures in their critical points was found in various laboratory electric discharges, severe weather phenomena and cosmic space, that cover the range 10^{-2} - 10^{22} cm. The smallest objects of such a type appear to be the ›hot spots‹ in the high-current electric discharges (namely, Z-pinches and plasma foci) while the biggest ones are as large as the entire galaxy.«

552: »The open end of a dendritic electric circuit or a local disruption of such a circuit (e.g., its sparkling, fractures, etc.) may self-illuminate it to make it observable. This suggests a new interpretation to some mysterious events which involve binary systems (often quasi-symmetric ones) like, e.g., ›colliding galaxies‹ and some dual nebulae. The first class may be represented by an ›intergalactic pipeline‹ (the dark, 20,000 light-years long string) of material flowing between two battered galaxies.«

555: »Image analysis of many space objects leads to the conclusion that the majority of observable objects in the universe are luminous ends of almost invisible (or almost completely transparent) formations of filaments. The structure of these filaments can be seen and/or inferred only near their luminous ends. We only ›see‹ the luminous ends which in turn can be the reason that we see in the Universe what amounts to be only a few percents of the entire mass. One can show not only luminous objects of galaxies, but also galaxies themselves are luminous open ends of complex structure of fractal matter. […] The large-scale coaxial-tubular structure of the fractal matter […] can be interconnected in a unique network of the Universe. All objects of this network are directly connected. Neighboring galaxies are especially strongly connected when they belong to a single tree-like filament, and they appear as ends of cut-off branches.«

560: »Previous studies have shown the filamentary structures in the cosmic web influence the alignments of nearby galaxies. […] We find that LOWZ galaxies exhibit a small but statistically significant alignment in the direction parallel to the orientation of nearby filaments. This effect is detectable even in the absence of nearby galaxy clusters, which suggests it is an effect from the matter distribution in the filament.«

567: »We shall not be able to claim that we understand the universe until we know where they [quasars] are, what they are, and how they function!«

571: »Suppose that there are in fact two classes of quasars. Those of type I (which includes the vast majority) are cosmologically distant, but a few (type II) are the «dwarf" results of remarkable explosions in relatively nearby galaxies.«

572: »Quasars are classified further into core-dominated and lobe-dominated quasars. These are core-dominated if the radio emissions emanate mostly from the core, otherwise it is a lobe-dominated one. The core-dominated ones possess properties like flat radio spectra […] as a result of synchrotron self-absorption mechanism, cores with extremely brightness, broad emission lines and one-sided jets/lobes. These types of quasars dominated the survey at high frequencies and high redshifts. […]
On the other hand, lobe-dominated quasars, unlike the core-dominated, have two extended lobes straddling a weak compact core. They are also high luminosity sources […] characterized by steep radio spectra […] with broad emission lines; […]. They also have higher redshifts when compared with radio galaxies.«

573: »The combined and processed images reveal Lya emission from a giant filamentary structure centered on the f/g quasar and extending continuously toward the b/g quasar.«

578: »Is it significant that the brightest radio quasar in the sky falls in the dominant cluster in the sky— and forms a pair with the brightest radio galaxy in the cluster, almost exactly aligned across the brightest galaxy in the center of the cluster? […] It is incomprehensible to me how the field could have gone on believing quasars were at their redshift distances after even this one single result.«

579: »Because of its position and because it is optically the brightest radio emitting QSO, there has always been a suspicion that 3C 273 might be a member of the Virgo cluster. […] There is considerable evidence from the morphology and from the X-ray emissions that this may be the case.«

581: »There is no question but that it [the cloud] is a member of the cluster. Thus the proximity of 3C 273 to the cloud and the alignment of the jet and major axis of the cloud provide strong evidence for the association of 3C 273 with the Virgo Cluster. […] the alignment of the jet and the major axis of the cloud […] leads to a probability ~10^{-3} that this is a chance event. 3C 273 is still unique after 25 years of looking for QSOs, and this hydrogen cloud is also unique so the fact that these two objects are found within 44' of each other in the sky would seem to be highly significant despite the fact that the redshift of 3C 273 is nearly 40 times the redshift of the cloud and the Virgo Cluster.«

582: »In some of the first associations of quasars with galaxies the quasars were radio sources. Radio sources, in general, have always tended to pair across galaxies, and each member of the pair tended to resemble the other in radio flux, spectral index, and resolution characteristics. Cases began to occur in which more than one quasar was associated with a particular galaxy. It then began to be noticed that the properties of the associated quasars also tended to resemble each other. Particularly striking were similarities in redshifts of quasars associated with the same galaxy.«

584: »The pair of radio sources had been identified, first because of its closeness and orientation, as most likely

belonging to the galaxy IC 1767. On further inspection it turned out that the apparent flux and spectral index of the radio sources were very similar. Finally, it turned out that both radio sources were known to be rather bright, in apparent magnitude, quasars. It was not known at the time of the writing of that paper, but it later turned out that the redshifts of the two quasars were closely the same.«

585: »We see that in the case of the nearby galaxy NGC 3628, not only an HI plume but narrow PSPC X-ray filaments emerge along the minor axis connecting the z = 2.15 and z = 0.995 quasars back to the active nucleus. In addition the quasar in the filament has a counterpart, closely matched in redshift, on the other side of NGC 3628.«

586: »We believe the improbability of finding quasars so close to NGC 3628, including two of them linked directly to the nucleus by an X-ray filament, combined with finding the galaxy to be so actively ejecting associated plumes of gas, optical and X-ray material in these directions is key confirmation of the previous evidence for ejection origin of quasars.«

589: »What was exciting about this, of course, was that two unrelated X-ray quasars had only about one chance in 100 of accidentally falling this close in redshift. That probability, times the vanishing probability of finding such a strong pair of X-ray sources across an arbitrary point in the sky, made the whole computation a waste of time—here was clearly another physical pair across a Seyfert.«

594: »It is quite clear that given a random distribution of quasars over the plate the probability of finding two such exact alignments with closely similar redshifts so close together in the sky is extremely small. […] It would appear that if any significance is attached to the triplets, it would imply a non-Doppler interpretation of the redshifts.«

595: »However, it is difficult to assess the physical significance, if any, of accidentally discovered unusual alignments when the low probability of their occurrence depends on the joint probability of many different features. This is particularly true when there seems to be no imaginable theory which could account for all the alignments and numerical coincidences.«

598: »Two bright pointlike sources, for which faint blue stellar objects are proposed as counterparts, are located symmetrically and equidistant to the NGC 4258 nucleus […]. They are aligned with the tips of the anomalous arms and, if connected to the galaxy, may represent ejecta from the nucleus.«

600: »Then the dance of evasion began. It was necessary to obtain optical spectra of the blue stellar candidates to confirm that they were quasars and ascertain their redshifts. A small amount of time was requested on the appropriate European telescope. It was turned down. Pietsch's eyes avoided mine when he said ›I guess I did not explain it clearly enough.‹ The Director of the world's largest telescope in the U.S. requested a brief observation to get the redshifts. It was not done. The Director of the X-ray Institute requested confirmation. It was not done.«

605: »Each galaxy is formed as the result of the activity of its nucleus and the secondary centers of activity released from it. […] Here the different forms of activity of the nucleus sometimes correspond, in terms of basic causes,to the different subsystems which develop in a galaxy. In one case, it may be explosions, during which highly massive dense bursts are ejected, in a second, it may be outflows of classical gases, in a third it may be the ejection of clouds of relativistic gas, and in a fourth, a prolonged and, possibly, relatively quiescent efflux of spiral arms.«

609: »NGC2639 [...] shows a group of seven X-ray sources coming out exactly along the NE minor axis. These latter, closer sources are apparently most recently ejected. The outer pair of quasars may represent earlier ejection when the minor axis was rotated in a somewhat different position. In general, such minor axis rotation could account for the greater spread in minor axis alignment of the older companion galaxies […].«

611: »It is seen that the quasars preferentially come out in a cone angle of about ± 20°. The companion galaxies are preferentially confined within about ± 35°. This difference is in the expected direction because as the quasars reach their maximum extension and slow down, they are vulnerable to pertubation by objects at that distance and hence will fall in again along slightly deviated orbits.«

614: »In the case of NGC 3079, the strong disruption exhibited by the optical image makes it seem likely that there has also been ejection in other directions than the minor axis.«

615: »[…] two pertinent data are reported: 1) The X-ray bright quasars, including the double quasar, within this area around NGC 3079 are overly dense by about 10 sigma from a conservative estimate of the all sky density of such objects; 2) HI extensions from NGC 3079 point rather closely in the direction of the double quasar and there is some alignment of continuum sources around the double quasar in this same direction.«

617: »Many spiral galaxies have a complex structure which evidences the fact that the processes of ejections and

outflows from their nuclei took place at different times and in varions ways. For instance, the spiral arms of our Galaxy and their stellar population are concentrated in the fundamental plane of Galaxy, but the Magellanic Clouds and weak spiral arm connected with them, are located in a quite different plane. Thus, it seems that the cosmogonic process connected with the origin of the arms of our Galaxy occurred twice.«

621: »The fact that there are so many quasars all of nearly the same redshift around this galaxy marks them as being associated with a high degree of probability. [...] Further evidence is even available from the individual redshifts of the quasars. Deviations [from the narrow Karlsson peak raus] are very small but almost perfectly balanced plus and minus across the galaxy […].«

623: »A peculiar disturbance of both spiral arms which contain quasars is evident […]. As these arms progress outward, each appears to split shortly before encountering a quasar. At the point of splitting, in each arm a large H ii region complex is prominent, after which the arms continue weakly on both sides of the quasars.«

624: »It can be argued that the weak, disorganized spiral-arm structure in Scd and Sd spirals is a consequence of less energetic ejection activity from the nucleus of these kinds of galaxies. If quasars are also ejected from the nucleus, they may be ejected with much less kinetic energy and consequently will be found closer to the boundaries of this kind of galaxy.«

626: »Apart from the division of the nuclei of galaxies, processes of relatively small masses from the nuclei of galaxies may occur in nature. These ejected masses can, over a short period, turn into conglomerates made up of young non-steady stars, interstellar gas and clouds of high energy particles.«

627: »Galaxies of the Sc type and those with still more disrupted arms often contain bright condensations which are rich stellar associations. […] Such condensations can be looked upon as companions of the galaxy […]. Thus, there is no clear-cut boundary between usual condensations in the arms and companion galaxies.«

630: »The outer regions of the disk are very disturbed and from it leads a single, long arm or filament which terminates at a smaller companion galaxy.[...] The companion is the only conspicuous galaxy that is in the vicinity of NGC 7603, the single filament leads directly to the companion and terminates exactly at the position of the companion. There can be little doubt that the companion is physically connected to NGC 7603.«

631: »Arp considers that the companion is not an accidental projection of a background galaxy onto the spiral arm of NGC 7603 because of the peculiar nature of both objects and because the halo surrounding the companion is brighter at the point where the luminous filament from NGC 7603 touches it, indicating physical interaction.«

632: »As far as we are aware, this is the most impressive case of a system of anomalous redshifts discovered so far.«

633: »A knot (object 2) is perfectly centered in the line of the filament and positioned where the filament connects to NGC 7603B. The other knot (object 3) is also perfectly centered to within 1 arcsec in the filament, and is positioned where the filament connects with NGC 7603. There is also a second filament which sweeps around from the main galaxy through the position of the companion NGC 7603B.«

634: »We have clearly shown that two of the compact emission lines objects in the filament have redshifts very much greater than those of NGC 7603 and its companion galaxy. Thus we have presented a very well known system with anomalous redshifts, NGC 7603, to be an apparently much more anomalous than was previously thought. There are 4 objects with very different redshifts apparently connected by a filament associated with the lower redshift galaxy. This system is at present the most spectacular case that we know among the candidates for anomalous redshift.«

636: »Ironically, after 30 years, [...] two quasar-like, high redshift objects (z = .24 and .39) have recently been measured in this same connecting filament [...]. The results, moreover, fit well with the model we have suggested here, wherein a plasmoid entrains a trail of matter from the ejecting galaxy, is slowed and evolves into a high redshift companion. Subsequent ejections follow this magnetic tube, and we see two now in an earlier stage of evolution at z = .24 and, closest to the Seyfert, z = .39.«

637: »According to the line ratios, these objects are HII-galaxies but are quite peculiar: the very intense Ha [] is indicative of a vigorous star-formation galaxy. Only ∼2% and ∼1 % resp. of the normal HII-galaxies have a so high EW. However, if they were dwarf HII-galaxies, these high EWs would be within the normally expected values. If we consider the redshifts as indicators of distance, the respective absolute magnitudes would be: MV = −21.5±0.8 and −18.9±0.8. However, if we consider an anomalous intrinsic redshift case […], the results are: MV = −15.2±0.8 and −13.9±0.8 resp. In this second case, they would be on the faint tail of the HII-galaxies; they would be dwarf galaxies, «tidal dwarfs", and this would explain the observed strong star formation ratio: objects with low luminosity have higher EW(Ha). Of course, this would imply that we have non-cosmological redshifts.«

641: »The western quasar (D) is connected directly into the elongated galaxy nucleus! There is absolutely no way to escape the overall result that the quasars are connected and generally elongated toward the low redshift nucleus.«

643: »The detection of luminous connections would be the most direct evidence for the physical associations of the quasars and galaxy. At this point it must be left to the reader to judge whether the observations represent evidence for such connections.«

669: »It has been shown that there is most probably a real discretization of quasar redshifts, and that this discretization with the present data can quite accurately be described as a geometrical series [...]. The two peaks around z = 0.30 and z = 0.60 have been discussed by Burbidge (1968), who concluded that they were real. This is certainly in favour of the present hypothesis, but a still stronger argument for the reality of the relation found is that it establishes a connection between the peaks at z = 1.956 and z = 0.061, which can also be regarded as a connection between QSOs and objects related to them, that is, N-galaxies, Seyfert galaxies, and some compact galaxies. It seems unavoidable to conclude that redshifts of QSOs, and probably also the redshifts of these related objects, are intrinsic to the objects.«

670: »The mean quasar redshift turns out to be exactly on a Karlsson peak when transformed to the reference frame of AM 2230-284. The exactness of the transformation would seem to rule out its being accidental. It is also notable that zK = 1.96 is the most accurately known and the most populated of the quasar, high periodicity peaks.«

671: »There are two important conclusions to be drawn: The first is that the quasars must originate in an ejection process. The minor axis is the expected ejection direction from an active galaxy nucleus […]. The second is that the chance of the observed quasars falling so closely along a predicted line by accident is negligible, thus confirming at an extraordinarily high level of significance the physical association of the quasars with the low redshift galaxy.«

672: »The z = .81 redshift then may represent a short-lived phase in evolution from the .96 to the .60 peak.«

677: »An examination of the positions and redshifts of the compact, QSO-like objects reported near the Seyfert 2 galaxy NGC 1068 has revealed many relationships that suggest strongly that the objects have been ejected from the galaxy. The results indicate that the objects have been expelled in at least four similarly structured ejection events from a point near the centre of NGC 1068 […]. The large redshifts of the objects cannot be explained by their modest ejection velocities and require an additional, large intrinsic component. […] The consequences of this conclusion are enormous.«

680: »It should be noted that the central galaxies here are low redshift so that only small corrections to their rest frames are needed. But in cases where the ejecting galaxy has appreciable redshift it is critical to correct the observed redshifts. Failure to do this has led to some well publicized claims of non-quantization of quasar redshifts.«

681: »[…] correction for an appreciable redshift of the parent galaxy moves the corrected quasar redshift onto, or much closer to, the expected peak redshift. I often point out these cases because I argue that if the quasar were not associated with the galaxy the correction would not, in general, move it onto the peak. If the correction moves the redshift particularly close, this is evidence for the physical association of this particular galaxy and quasar.«

682: »To summarize, our four different statistical tests confirm an underlying spiky nature of the redshift distribution […]. There is reasonable evidence to support the claim of periodicity of $\zeta = 0.0565$ and also perhaps of a periodicity in the range 0.0127 - 0.0129. […] We do not wish to draw any deeper conclusion from these results, beyond stating the fact that the peaks and periodicities have remained for more than two decades despite a thirty-fold augmentation of the data. Any theory of redshifts, whether intrinsic or cosmological, will find in these results a stiff challenge.«

685: »Galaxy and quasar redshift values form sequences, which are not only discrete in amplitude but also contain periodic components. [...] The existence of periodicity for quasar and galaxy families is thus firmly established.«

686: »The situation at present seems to be that the redshift peak of $z_0 = .06$ was first recognized almost 40 years ago. As fainter quasars and galaxies were measured the $z_0 = .060$ to .064 objects grew in number. They were reported on most of the increasingly large telescopes. […] the population of the z = .06 galaxies reaches numbers into the 50's or more per larger galaxy.«

687: »At the moment we may not know what causes the Karlsson peaks and periodicities but we do know that empirically the phenomenon treats quasars (e.g. z = 1.96) and active galaxies and galaxies (e.g. z = .06) equally. The .06 objects are mostly galaxies but they are preferentially centered around lower redshift parents in classic groups.«

694: »The evidence obtained by W. Napier and B. Guthrie on the smallest quantization interval of 37.5 km/s [...] is the most powerful of all the quantization evidence. In all directions in the sky up to redshifts of 2600 km/s he finds galaxies quantized in this small interval of redshift with enormous significance. The most important consequence of the

observation is that real velocities of galaxies cannot average much more than about 20 km/s because, projected at random angles to the radial line of sight, they would wash out the 37 km/s quantization.«

696: »If the relation is real, as it seems, what could be the physics behind it? [...] The relation could present evolution of quasars with decreasing density and a corresponding drop of the redshift. It looks, however, not to be a smooth, continuous transition, but a series of jumps to lower densities and corresponding redshift jumps to next lower value of the Karlsson sequence. This scenario has already been suggested by Arp. [...] The density curve goes apparently to an asymptotic limit with increasing redshift. As a consesquence, at large redshifts only a small drop in density causes a large decrease in the redshift. This could account for the decreasing number of QSOs with redshifts zo > 3 and for the absence of very large redshifts.«

697: »Another consequence to be expected by this evolution scenario is the increase of radius of quasars. The end product of evolution of local quasars could be small mass companion galaxies. Galaxies beget companion galaxies? This scenario should be considered seriously. If confirmed, such a scenario could probably require re-considering the theory of origin of galaxies in general. On the ›density-redshift‹ diagram, there are no quasars below reduced density ~0.02 g/cm^3. Could it be that QSOs have already evolved into galaxies?«

705: »There is now tantalizing evidence that quasars and stars are somehow related. Could this link be expected in the process of their origin? This is yet another surprising hint which is worth to pursue further. One could ask also a question, what about the planets?«

707: »The fundamental question is the intepretation of redshifts.«

708: »Probably the biggest problem in cosmology is one that many people don't even think about or want to think about. It has to do with the nature of the redshifts of astronomical bodies. […] In my view, there is abundant observational evidence that not all of the redshifts of astronomical objects can be explained by expansion, by Doppler effects, or by gravitation.«

709: »We should not replace a known, familiar principle by an ad hoc explanation unless we are forced to that step by actual observations.«

710: »There is a frequency shift that occurs for each ionospheric reflection. A double hop path gives double the frequency shift of a single hop path.«

711: »The measured results shown here indicate that we have found a local red-shift which is not a Doppler shift. Then we can propose that the astronomical Hubble red-shift is not necessarily Doppler shift due to the Universe expanding after the big bang, but it could be a continuous process.«

712: »The ionosphere is both an electron gas and a plasma. The physics of ›Landau damping‹ applies to EM energy such as light entering a plasma. It states that light on passing into the plasma loses energy to the plasma ions and electrons, more so to the ones travelling faster in the direction of the light, that is when the coupling to the light is greater. For a radio wave entering and being reflected from the ionosphere energy is lost, but here we have discovered that it is thereby changed to a lower frequency. This is believed to be a new discovery.«

714: »The experimental situation is rather confusing in so far as many of the experiments aimed at the observation of PPS have produced results that are partly contradictory. However, in cases dealing with resonance lines blue shifts have been reported although photographic observations have also led to irreproducible red shifts.«

715: »When perturbers come close to the nucleus, [...] they lead to a non-zero average interaction and contribute to shift the radiator states. So, in addition to being broadened by higher-order interactions, the lines will suffer a shift due to the difference of the average interaction between the upper and lower states of the transitions.«

716: »It should be pointed out that the irreproducible red shifts […] have not been considered since they are believed to be independent of any polarisation effect.«

717: »As early as 20 years ago, interest in spectra of ionized radiators in dense plasmas motivated ad hoc calculations of redshifts induced by perturbing the electron shielding of the nucleus. […] These calculations of what was called the plasma polarization shift frequently overestimated the shifts observed experimentally. […] In the past, there have been difficulties in measuring line shifts accurately, but recent line-shift observations have confirmed the calculations. […] The difficulties described above allowed the question of the existence of plasma-induced shifts to remain unresolved in the minds of many. In the past few years, more evidence of plasma-induced line shifts has begun to appear. […] Preliminary calculations indicate that the plasma-induced line shifts will have a substantial impact on other aspects of plasma spectroscopy [...]. We believe that incorporating this shift into a broader picture of plasma physics is necessary

and will lead to enhanced analytic capability.«

722: »Based on the experimental result we deduced the electron density is up to 10^{17} cm^{-3} from the spectral broadening, and thus it plays dominant role in the red-shift of the spectral lines. The electric field produced by the high free electrons density induced the Stark broadening of spectral line, and caused atomic-level interval changing, which induced the wavelength shift. […] Preliminary analysis indicates that, when the electron density of plasma plume increases, the difference of the atomic energy level is reduced, and then the red shift is raised.«

724: »The broadening of spectral lines is a complicated function of the environment of the radiating atoms and ions, and there are several possible broadening mechanisms.«

725: »Here we report measurements of Hα for electron densities in excess of 10^{20} cm^{-3}, conditions under which the line shifts more than 100 Å to the red as it broadens to more than 1000 Å full width. […] Hα shifts monotonically and nearly linearly to the red with increasing density under the reported conditions.«

728: »Another decisive factor is the length of the light path in the plasma. Starting near the solar limb, the light's way x through the chromosphere is longer than the shortest distance h, if the light leaves from the center of the solar disk. The chromosphere is roughly 2000 km deep; a thin layer called solar transition region follows, where the density of unbound electrons drops suddenly to 1% or lower. In the following areas (the corona and the heliosphere), the density decreases further. Here, the light's energy loss is negligible and nearly equal for both paths, the major loss occurs in the chromosphere.«

730: »It has been known for many years that the 0 and B stars in the Orion Nebula show a pronounced redshift relative to the lines in the spectrum in the nebula itself. Findlay-Freundlich [101 states: ›The B stars in the Orion Nebula group show a systematic redshift relative to the lines of the Nebula, amounting to at least + 10 Km/s.‹«

732: »Whatever the origin of the shift may be, it is probably to be sought in the process occurring within the star atmosphere itself.«

733: »A problem arises because it is observed that the average radial velocity (as calculated by the redshift) of the center of mass of each component of the system is not the same for each of the two components. Celestial mechanics predicts that when two bodies rotate around the center of mass, the average radial velocity component of either star with respect to us must be the same. In many cases, this is contrary to observations.«

734: »One notices that all those binaries have one component with a much higher temperature than the other one.«

739: »The observational results are an anomaly in mainstream cosmology – and yet they are just that – repeatable results/observations that must be explained. […] It must be remembered that the Big bang/expansion theory predicts no redshift in these lines at all. Mainstream Physics can offer no explanation for this phenomenon.«

748: »When the emission lines first appear, therefore, the light; will be subject to maximum absorption, and the effects of this atmospheric absorption will decrease as the period progresses, on the present view of these outbursts. This is in fact what is observed to happen. Groups of lines, such as the Balmer series of hydrogen, and smaller groups, or multiplets, in the iron spectrum, for example, have definite intensity ratios in laboratory spectra. When the bright lines first appear around the time of minimum light the relationships between these line intensities are found to be considerably modified by the differential absorption to which they are subjected on the way out by the molecules of metal oxides, etc., in the atmosphere. This mutilation of the customary relationships gradually decreases as the outburst continues, until, towards its end, their ratios approach those observed in the laboratory.«

749: »Absorption lines are an ›absence‹ of photons and so one would not expect an ›absence of lines‹ to broaden. What happens is the continuum broadens into the absorption lines making them narrow with increased redshift. A study of the literature on the Lyman α Forest shows just this.«

750: »Using femtosecond pulses, the experimental verification is easy in an optical fibre. A complete study is easier using the improvement of the effect resulting from the non-linearity induced by the high power of the femtosecond lasers. It is the ›Impulsive Stimulated Raman Scattering‹ extensively studied in some laboratories.
Using the nanosecond pulses which make the ordinary light requires the use of a low pressure gas having Raman resonances at frequencies of the order of 100 MHz in well populated states. It would require an expansive experiment which does not seem useful because the extrapolation from the laser experiments seems reliable, and the experimental conditions in the solar system are well known.«

752: »One can see that their luminosity is about the same as standard galaxies and not as millions of galaxies as believed previously.«

753: »But if the cause of these redshifts is misunderstood, then distances can be wrong by factors of 10 to 100, and luminosities and masses will be wrong by factors up to 10,000. We would have a totally erroneous picture of extragalactic space, and be faced with one of the most embarrassing boondoggles in our intellectual history.«

754: »The universe is, so to speak, all-electric, and [...] electric fields and their breakdown in electrical discharges account for the observed phenomena and accelerate the process of universal evolution from universe to galaxies, from galaxies to stars, from stars to planets and, possibly, from large planets to satellites.«

755: »With few exceptions modern theories of cosmology have come to be variations on the homogeneous, isotropic models of general relativity. Other theories are usually referred to as ›unorthodox‹, probably as a warning to students against heresy. When inhomogeneities are considered (if at all), they are treated as unimportant fluctuations […].«

759: »The spiral galaxies are conspicuous for their bright, young stars and earlier integrated spectra. The radio galaxies are emitting radiation due to the rapid motion of charged particles, an activity which would generally be expected to die down with age. As a result, the configuration of galaxies in these two panels looks very much like a giant spiral, with the younger objects out toward the ends of the arms.«

760: »The Local Supercluster is the largest aggregate of material about which we have certain knowledge. We are near the edge, at about 15-20 Mpc from the center. When we get through remapping all the young, high redshift objects like quasars and active galaxies to their correct distances rather than their redshift = velocity distances, then the Local Group and Local Supercluster will become much more populated relative to the more distant regions than is presently believed. In fact, it may be relatively quite empty beyond the confines of the Local Supercluster.«

761: »The theory suggested that occurrences on a galactic scale have probably been preceded by a similar history of events on a universal scale and in particular that there may be two populations of galaxies corresponding to the two stellar populations in our galaxy. The one population of older galaxies would be forming contemporaneously with the building up of the universal electric field. The other of younger galaxies would be formed relatively quickly in the gas of increased density aggregated along the universal discharge arms. […] the galaxies in these clouds will be found to be younger than the lone galaxies, but that the matter comprising them will be found to contain a higher proportion of heavy atoms than do the others, since it will have been subjected to thermonuclear temperatures during the universal discharges.«