Different but still the same

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A review of
A Different Approach to Cosmology
by Fred Hoyle, Geoffrey Burbidge and Jayant V. Narlikar
Cambridge University Press
Cambridge, UK, 2000

Early history

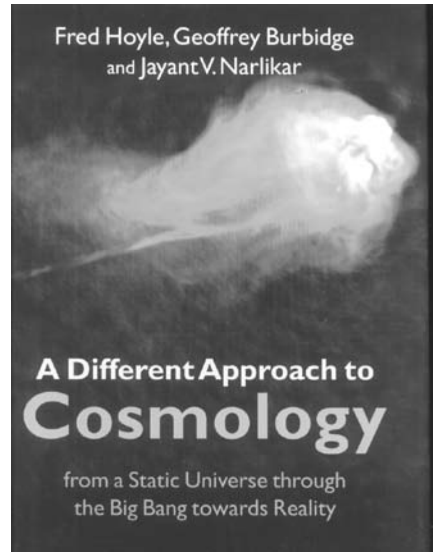
The authors of this book, Hoyle, Burbidge and Narlikar, are well-known critics of the big bang cosmology, and promote a very different steady-state cosmology. They devote a considerable portion of their book to reviewing the history (starting in the early 1930s) and the development of observational astronomy at both optical and radio frequencies. This part is a useful summary of the early development of cosmology. They introduce the early relativistic big bang cosmologies with the usual evolutionary assumptions of homogeneity (no preferred observational position) and isotropy (no directional differences). The velocity-distance relation for objects outside our galaxy and hence the determination of the Hubble constant is well covered. This leads to the age dilemma, which initially resulted from the alleged ages of Earth rocks being older than the universe, as determined from the inverse of the Hubble constant (H_0^{-1}). Later, after the Hubble constant had been revised down about eight-fold, the alleged ages of some stars were older than the universe.

They explain the original steady-state (SS) model developed in 1948, by Bondi and Gold,[1] and Hoyle.[2] Contrary to popular belief, the Hoyle version of the SS theory did not violate the law of conservation of matter and energy. The authors are very critical of the hostility the SS theory received in the 1950s and '60s, due to this underlying creation concept, when the big bang (BB) inflation models in the 1980s invoked the same principle. That is, a one-time event in the earliest time was acceptable but not a continuous creation process at a rate that made it locally undetectable. They (erroneously) infer that the BB gained acceptance because of parallels with the Creation event described in Genesis.

The professional astronomical community mounted an all out effort to disprove the SS model. The first assault came with the discovery of the Stebbins-Whitford effect, published in 1948. The SS model predicts that all samples of galaxies have the same average age. That is, there is no evolution as a whole as a function of epoch or time. Stebbins and Whitford[3] measured the colours of distant galaxies and reported that they were much redder than predicted by the SS model, even after corrections were made for interstellar dust etc. Although the effect was proven spurious by 1952,[4] it was not well understood until much later. Even after it was understood, the effect was still used by theoreticians against the SS model for a decade more, such was the prejudice.

It was hoped the universal deceleration parameter would prove the difference as there should be a separation in the models at a redshift $z \sim 0.2$. Measurement error proved to be too great.

Next, radio-galaxy source counts were used to differentiate which model was correct. Mostly drawn from the work of Ryle,[5] the argument was made that the evidence didn't support the SS model. However, the contentious parameter, the slope of the plot of the log of the number of sources at a given magnitude, was revised down many times. Bias seemed to play a greater role than evidence.



Cosmic microwave background

Then came the microwave background radiation (MBR), discovered by Penzias and Wilson[6] in 1965. Several schools of cosmologists, including R.H. Dicke of Princeton had, years before, because of their belief in the hot BB, expected that the microwave background would be found. So when it was, it sounded the death knell to the steady-state model. However, in the book, Hoyle *et al.* describe the quasi-steady-state-creation (QSSC) model that gives rise to a near-perfect blackbody curve, fitting all the COBE microwave radiation data. They show how much personal belief and prejudice has entered into cosmology, particularly into the effort to disprove the SS model and prove the BB model.

The authors explore the history of the MBR. In 1941, McKellar[7] interpreted interstellar absorption lines in the blue part of the optical spectrum arising from diatomic molecules CH, CH+ and CN, as being excited by background radiation with a blackbody spectrum and a required temperature of 2.3 K. Due to the Second World War, McKellar's paper was soon all but forgotten. In 1948, George Gamow[8] and Alpher and Herman[9] predicted that if helium were synthesized from hydrogen in the early universe, then at the present time a 5 K thermodynamic radiation field would be observable.

Later, in the 1950s, Gamow raised the estimate to 10 K and Fred Hoyle argued with him that, if it were true, McKellar (in 1941) would have obtained 5 K or more for the excitation temperature of the ground state of the CN molecule.

By the early 1950s, it was generally accepted that the elements from carbon upwards were produced in stars, which challenged the BB orthodoxy. When J. Robert Oppenheimer announced this observation, he said it was a correct idea emerging from a wrong one: the SS theory. The supporters of the SS model worried about helium formation, as its abundance should be about a quarter of all the baryonic matter in the universe, which from Oort's estimate of galactic material density, was put at 7.5×10^{-32} g cm^{-3}. Multiply this by the energy derived from the conversion of a gram of hydrogen to helium and it means the radiation background should be 4.5×10^{-13} erg cm^{-3}. This was a great embarrassment to the steady-staters as this result is greater than the observed energy density of starlight. They argued amongst themselves how to answer it. Gold was in favour of a thermalised background, because natural processes always tend to degrade the quality of energy. But Hoyle and Bondi could not see any thermalising agent. Had they made this connection they would have obtained the temperature of 2.74 K in 1955.

In 1982, Wright[10] suggested that metallic whiskers might be the cause of large infrared emissions from interstellar gas clouds. Fred Hoyle recognised here the thermalising mechanism that he lacked in 1955. But it was 30 years too late to impress the BB advocates. If only they had the wit to recall McKellar's determination of the 2.3 K for the thermal excitation of CN, the BB theory would not have been on stage at all. In 1950, it was Fred Hoyle who christened the 'big bang' model, inventing the term that was intended to ridicule it. In 1965, the discovery of the MBR seemed to vindicate the BB at the same time sounding the death knell of the SS model. Despite all efforts, the name has stuck and with the addition of the word 'hot', we today have the 'hot big bang' cosmology upon which all modern evolutionary theories are based.

Creation episodes

As far as the origin of the light elements is concerned, the authors give credit to the BB model for predicting the universally observed abundance of helium. They say it is the best, but also the only point in favour of the BB model. However the prediction was artificially acquired through hypothesis of the baryonic density, a totally *ad hoc* coefficient, hence it is not a true prediction. It is the direct result of the assumption of radiation domination in the early universe, an axiom of the BB cosmology. The microwave background is merely a restatement of that axiom. The new QSSC model of Hoyle *et al.* does not suffer from this problem because radiation is observed being produced by stars. Eventually this would result in a background radiation density within an order of magnitude of that observed. Nowadays the observed 2.73 K temperature of the microwave background dictates the present day value of the density of galactic material at about 10^{-31} g cm^{-3}.

The BB cosmology requires all matter in the observable universe (except for the very small fraction of heavier elements produced in stars) to be created at the one time, within 10^{-36} seconds of the BB. The QSSC model describes a continuous creation of matter within nearly-black holes. The creation of the light elements occurred in these primordial fireballs, which result from the creation and ejection of matter from galactic centres. It is an uncorrelated process occurring throughout the visible universe.

Hoyle *et al.* describe a new heavy particle, a Planck particle (mass about 10^{-5} g), which is the result of gravitational energy ($\sim 5 \times 10^{18}$ GeV) and is able to 'tear open' the structure of space-time, from which the creation events emerge. These events result in showers of particles with masses of this order, which eventually decay into quarks, which in turn combine to form baryons and eventually hydrogen and helium. Rightly, they point out that in both BB and QSSC models, the creation of matter must occur. The difference is whether the products expand as a universal sea or in separated fireballs. The BB allows only for a balanced particle-antiparticle creation process but the QSSC theory requires fireballs of particles only. Their calculations result in a helium mass fraction between 0.22 and 0.24 and deuterium/hydrogen and helium 3/hydrogen ratios at those determined from observed abundances.[11]

Though the hot BB has become the modern model of choice, the observational data since the 1960s provide the strongest evidence that this model is not correct. Three major themes are outlined in the book:

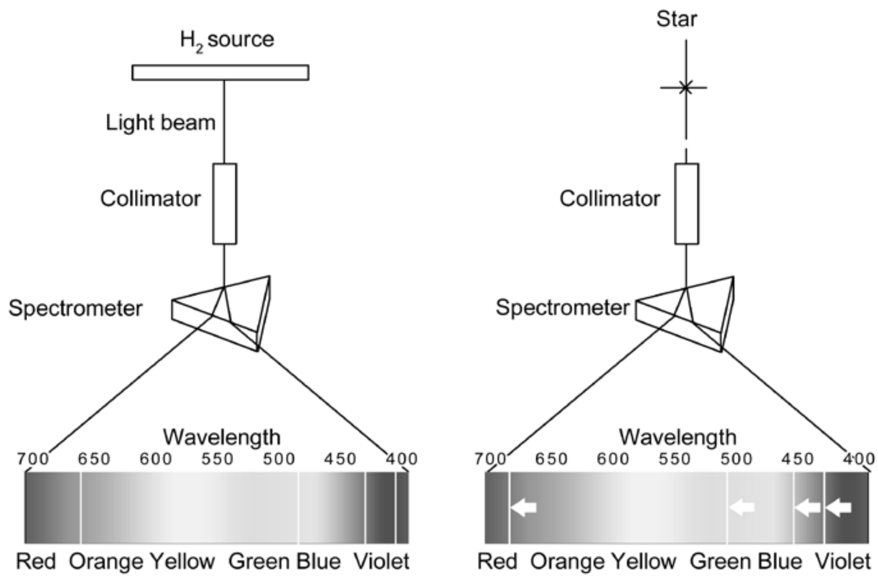
1. Not all redshifts are the result of the general expansion of the universe.
2. There is much evidence that galaxies, quasi-stellar objects (QSOs), etc. are generated and ejected from galactic nuclei and not from initial density fluctuations in the universe shortly after the big bang.
3. The observed rapid release of large amounts of energy from galactic nuclei comes from creation processes that are occurring in the present day universe.

Let's now consider each of these three themes.

Redshift and QSOs

Hubble showed a good correlation between redshift (in fact 5log(z)) and apparent magnitude due to expansion for normal galaxies. However, for QSOs there is no such correlation. In fact, for a group of 7,000 QSOs, it was found that their apparent magnitudes correlated with 5log(1+z), which is caused by the loss of energy due to the redshift (z) itself, and hence it is not a distance effect. A relationship is suggested between the observed redshift (z_0) of a QSO, a cosmological component (z_c), and a component intrinsic to the QSOs (z_i). The intrinsic component causes a large scatter in the apparent magnitude of QSOs. They may be related by:

$$(1 + z_0) = (1 + z_i)(1 + z_c) \quad (1)$$



The distinct emission spectrum for hydrogen can be measured in the laboratory. When the emission spectrum for hydrogen is measured from distant stars, the lines are often shifted toward the red end (shift not necessarily to scale). This effect is known as the red shift.

Another remarkable property of QSOs is that they exhibit very rapid variations in luminosity (in both optical and radio emissions) on time-scales of a year or less. This at first was thought to be impossible, but was soon confirmed by further observations. This means the size of the emitting region cannot be larger than the light travel distance across the object over the timescale of the variation. The current view is that QSOs are no more than 100 AU across, or the same size as our solar system. Most QSOs have large redshifts which, if interpreted as a measure of distance, would mean luminosities ~ 100 times those of normal galaxies. These facts led to what was called the Compton paradox,[12] a physically impossible state due to the radiation densities in these sources.

There are two ways out of the paradox. The first is to assume that the QSOs are not as distant as their observed redshifts suggest, that is, $z_c << z_0$. The second is to assume that the radiating surfaces must be moving relativistically, so that instead of the limit on size (R) being $R \leq ct$, where t is the timescale for variation, $R < gct$, where $\gamma = 1/\sqrt{1-\left(\frac{v}{c}\right)^2}$. This was the only way to explain the observed redshifts of the rapidly variable optical sources in terms of a cosmological origin.

However, radio-astronomers soon began to measure outward motion of structures within QSOs over timescales of years, that suggested components moving at a few to about 10 times the speed of light. Again, to preserve the conventional redshift interpretation, the radio-astronomical community have claimed they are detecting superluminal expansion (i.e. expansion at greater than the speed of light). However, there are examples of galaxies of stars whose distances are not in question, where such motion doesn't require superluminal expansion, just high speed (~ 0.3c). None of these less-than-satisfactory assumptions would be necessary if it were assumed that there is a large intrinsic redshift component.

In 1967 and 1968, Arp[13,14] began to identify radio sources near interacting galaxies. His observations suggested a physical association between some of those galaxies. However, the redshifts of the peculiar central galaxies are usually small whereas the redshifts of the radio-sources, usually associated with QSOs, are very large. Arp argued, on statistical grounds, that the systems must be physically associated and that the redshifts of the QSOs cannot be of cosmological origin, but have an intrinsic origin. Because his work was heavily criticised, he searched for radio-quiet QSOs near bright spiral galaxies with small redshifts. He found many candidates, which turned out to be high-redshift QSOs. Burbidge and others were able to develop the relationship between the observed redshift of the galaxy (z_G) and the angular separation (θ) of a QSO from its associated galaxy. The results, taken from 392 pairs, indicate that $\theta . z_G \approx$ constant. This shows without doubt that the vast majority of pairs are physically associated; therefore the observed redshifts of the QSOs must have an intrinsic quality.

Many photographic plates of galaxies and associated QSOs are reproduced in the book, in some cases showing connecting bridges of luminous material. Many of these images were recorded by Arp and, although he was heavily criticised, the data (of luminous bridges) are now generally accepted. Arp went on to find cases of two or three QSOs with very different redshifts lying very close to the centre of the same bright galaxy. He showed on statistical grounds that such associations must be physical because they were much more frequent than would be expected by chance.

Arp paid a heavy price in his professional career for suggesting something that threatened the prevailing cosmological paradigm. His own colleagues became so disturbed that they sabotaged his career and had his observing time at Palomar and Carnegie telescopes terminated. As a result, he took early retirement and moved to Germany. This was a clearcut blocking of his research because the implications were potentially so revolutionary.

Arp also observed another effect that strongly suggested a physical association. On many plates, it could be seen that the QSOs were aligned in a particular direction. In some cases, these directions were the same as well-known optical and radio synchrotron jets. Some QSOs are also X-ray sources and observations show they are being ejected from the parent galaxy but with very different redshifts to the parent galaxy.

From the above evidence, Hoyle *et al.* believed that the QSOs have their own intrinsic redshifts and that they are ejected from active galactic centres. This view is not generally accepted in the wider astronomical community. One excellent example, cited in the book, was the serendipitous discovery of four QSO images with z = 1.69 symmetrically placed around (and within 0.3 seconds of arc of) the centre of a galaxy with z = 0.039. After the four QSOs had been detected, Arp and Crane, using Hubble Space Telescope (HST) images, suggested in 1992 that this was a galaxy ejecting four QSOs with non-cosmological redshifts. The paper was turned down by all leading astronomical journals on the grounds that, as a number of referees put it, 'It must be a gravitational lens'. Finally it was published in a physics journal.[15]

The QSSC and the big bang

Hoyle *et al.* strongly suggest the evidence points to condensed objects being generated in the nuclei of galaxies and ejected periodically, along with hot gas and relativistic particles. They suggest that, because activity is found in galaxies at a wide range of distances, these creation episodes occur at all epochs. This contradicts the BB model where matter is created in a single episode, caused by density fluctuations in the early universe, and subsequently collapses into galaxies.

Hoyle *et al.* describe their QSSC model in detail in a general relativistic framework. It is an oscillatory model with episodes of intense creation when the universe scale factor approaches a minimum. It is a long age evolutionary model as is the standard BB model, but with cycles of the order of 100 billion years from one minimum to the next. The 'big crunch' does not occur, only an increase in density of galaxies. The theory has the bulk of optical radiation being thermalised in the contracting phase through the agency of carbon whiskers that absorb it and re-emit in the microwave region. The whiskers are not uniformly distributed but lumpy on the scale of clusters of galaxies. According to the authors, this is consistent with the COBE-satellite-examined sky on an angular scale where one beam width contains a rich galaxy cluster and the other not. As a result, fluctuations of the order of 30 μK are expected, in agreement with the COBE data as function of beam width.

The QSSC model predicts that galaxies observed at the last maximum in the oscillation will be faint because of distance but comparatively blue with a small redshift of about 0.2. This has actually been observed and small redshifts have been measured. In the SS model the time period between maxima and minima is about H_0^{-1}, the reciprocal of the Hubble constant. According to the model, because of our position in the current expansion phase, one would not expect to see redshifts much greater than 5. For larger distances, one would be observing a region in the previous contraction phase of the universe.

In fact, looking back towards the last maximum would yield blueshifts of the order $z = -0.5$. However, a typical galaxy of absolute magnitude –21 would be unobservable at an apparent magnitude of about +28.5 (allowing for about 6 magnitudes of absorption due to carbon whiskers occurring near the last oscillatory minimum). They predict that the best chance of seeing galaxies from the previous cycle would be from stars that are just a little beyond the last minimum which haven't had their light shifted too far into the blue to be affected by carbon whiskers. They maintain that there should be a profusion of galaxies at about +27.5 magnitude with very red stars due to their low mass and some reddening due to overall expansion. They argue that the larger modern telescopes are already seeing into the last oscillatory minimum of the QSSC.

The QSSC model predicts a period back to the last oscillatory minimum of 11 billion years, hence also the age of type I stars. They explain the apparent anomaly in the standard BB cosmology of the type II stars being older, because they were born in a period before this as far back as 18 billion years ago. But the Hubble law doesn't work past this oscillatory minimum and therefore the apparent contradiction. The standard BB model predicts a maximum age of 0.667 H_0^{-1}, which is little different from 0.652 H_0^{-1}, the time back to the last minimum. They make the point that although technology exists with the Lyman α series to measure redshifts out to z = 7, very few galaxies with redshifts greater than z = 5 are ever observed. Also there is a sharp decline in observed QSOs past $z \approx 2.5$. These facts are better explained by the QSSC cosmology and intrinsic redshift components.

The big bangers have had to revise their star/galaxy formation period down from z = 100 to z = 5, only by popular theoretical choice, brought about by observational necessity. And of course, the BB model requires that the entire universe came from a minute fraction of the post-inflation universe no more than a few centimetres in size. Dirac once said, 'That which is not observable does not exist', but these days what is said is, 'I know my theory is right. Therefore anything required to make it work must also be right whether observable or not.'

Hoyle *et al.* distance themselves from 'St John the Divine', (a euphemism for anyone believing the Bible). They would rather rely on what they call 'commonsense'. This commonsense is the belief that energy appears in the universe in compensating positive and negative forms. (This avoids non-conservation of energy). Negative energy fields are inherently explosive and, concentrated locally they offer the advantage of explaining the QSOs, radio galaxies and active galactic nuclei. When distributed uniformly, negative energy fields exert a negative pressure that manifests, according to Hoyle, in the overall expansion of the universe. I might add though, that, experimentally, negative energy has never been observed. They offer an explanation for the intrinsic redshift observed in QSOs and the like. It relates to the different times the matter was created as compared with the time of observation.

Another piece of observational evidence that they claim their model explains is the very high mass concentrations found at the centres of galaxies. Good evidence exists for mass concentrations of the order of 10^6 to 10^{10} solar masses. In the QSSC model, creation events release both positive and negative energy. The positive energy is associated with hot mass possessing inertia, but the negative energy is associated with special massless C-field particles, which freely escape the creation region. But, with the exception of neutrinos, this is not the case for the positive energy components, which lag behind the negative energy components. As a result, the interior of these regions are left with an excess of positive energy which ultimately builds to the nearly-black holes found at the centres of galaxies.

They make the point that the big bangers say these masses form 'somehow', with 'somehow' meaning a trivial falling together of a gas cloud, rather than by an as-yet-to-be-thought-of-process outside our current thinking. (Besides, the BB model cannot explain the collapse of the cloud anyway.) According to the QSSC model, the black-hole condition is never actually reached and the events associated with them happen on a cosmological time scale, 10^{12}–10^{14} s. The magnitude of the C-field energy is of the order of the closure density of the universe (100 times the baryonic density). This is true also for the positive energy contributing to the near-black holes. These near-black holes are a common phenomenon (in the model) with a smoothed mass density 100 times larger than the smoothed density of observed galaxies. Thus the 'missing mass' can be explained.

Faint blue galaxies

The Hubble relationship (large z therefore low luminosity) is clearly seen with the faint blue galaxies, however there remains a large scatter in z. This indicates that galaxies with intrinsically low luminosity appear at all distances. This was the state as observed out to $z < 1$ by 1992. However, work done since then at higher red shifts with the 10-metre Keck telescopes and with the Hubble Deep Field (HDF) galaxies in the range $z \approx 2$ to $z \approx 4$ have shown that the Burcher-Oemler effect[16,17] is a general effect. It shows that the fraction of galaxies with colours bluer by a magnitude of 0.2 more than the peak of the colour distribution, increases with increasing z, both in clusters and in the general field. Evolution is considered responsible because as we look back we see galaxies in a 'younger' star-forming state, as compared to galaxies viewed around $z \approx 0$.

There are many problems associated with this argument, mostly with sampling as the effect is still seen at a relatively recent epoch near $z \approx 0.2$, which is only 2 Gyr of look-back (assuming H_0^{-1} represents age). But one glaring inconsistency in the data is that the comparison of the blue luminosity volume counts (B) and the near infrared luminosity counts (K) when plotted as a function of apparent magnitude show a clear break in power law dependencies at different magnitudes. If the above argument were true, the $B - K$ difference would be constant over the break, but it isn't. One suggestion, consistent with the data, is that these fainter galaxies come from intrinsically low luminosity galaxies, which by the present epoch have burned down to unobservable low luminosities.

The HDF confirmed the increase in the fraction of blue galaxies with an increase in z. These galaxies are much more luminous than galaxies (allegedly) undergoing star formation in the present epoch, which is interpreted to mean an increase in star formation in the past. However, studies of the morphologies of these HDF galaxies, as a function of redshift, indicates a marked increase in the number of types which cannot be easily classified; up to about 50% or more at the faintest ones. As a result, a comparison with nearby galaxies is not easily made and the conclusion may be invalid.

Large-scale structure of the universe

The results from large-scale surveys of galaxies have shown regions of clusters, superclusters, strange line-like structures, walls and voids. Generally, galaxies lie on the surfaces surrounding low-density regions or voids. All efforts by big bangers to theoretically model the formation of these structures have failed as the theories relating the large-scale structure to the evolution of the initial conditions in the BB model usually predict that structures will be random. Observations seem to indicate the opposite, that there is periodicity in the structures, even regular with a unit size ~ 240 ± 40 megaparsecs (Mpc). However, the popular secular view at present is to disbelieve the data.

Peculiar redshifts

Starting more than 20 years ago, Tifft[18] showed that the differential redshifts of galaxies in the Coma cluster exhibited a periodicity with a value of $c\Delta z \sim 72$ km s^{-1}. Geoffrey Burbidge was one of the referees of his paper. Of the other two, both now deceased, one said the observations were done correctly but there must be something wrong with the statistical analysis. The other, a statistician, said the statistical analysis was done correctly but there must be something wrong with the observations.

Tifft went on to discover the effect elsewhere and over the years it was confirmed by others in pairs and small groups of galaxies. Tifft extended his work to include all galaxies when a suitable correction for solar motion was included. There is both a global periodicity for galaxies anywhere in the sky as well as a periodicity in the differential redshifts of adjacent galaxies. Recently, Guthrie and Napier,[19] after a very accurate redshift survey within the local supercluster, using two independent samples of 100 spirals, have concluded that quantised redshifts are present in normal galaxies with a periodicity of $c\Delta z \sim 37.6$ km s^{-1}, which is about half Tifft's original value. These data have been completely ignored by the cosmological community and are not explainable by any current theory.

Arp, on the other hand, has found examples of apparently normal galaxies connected by optical features with very different redshifts.[20,21] The best case is in NGC 7603, which is clearly connected to its companion[20] with redshifts $c\Delta z \sim 8{,}100$ km s^{-1} and 16,400 km s^{-1} respectively. The usual interpretation is that a foreground galaxy is confused with a background one. Observations like this are rare amongst galaxies, otherwise the Hubble relation would not have been found. But with QSOs the Hubble relationship doesn't hold well as the scatter is very large.

As mentioned previously, there seemed to be evidence that a large component of the redshift of galaxies was of some intrinsic origin and not associated with expansion. The tendency for different QSOs to have similar z was seen in the data, the first being $z = 1.955$. By 1968, 72 similar low-z QSOs and non-QSO emission line objects were examined and the redshift distribution appeared to be quantised with $\Delta z = 0.061$. By 1990, more than 700 objects were known with $z < 0.2$. The peaks in the distribution have become very prominent particularly at $z = 0.061$. After statistical analysis, the strong periodicity was shown to be real and the exact value of $\Delta z = 0.0565$. A second period was also found at $\Delta z = 0.0128$.

As the number of QSOs with greater redshifts were examined, it became apparent that there were peaks in the QSO redshift distribution also at $z \approx 0.30, 0.60, 0.96, 1.41$ and 1.96. It was argued that this was a spurious effect due to selection criteria. Finally a sample set was plotted that was not selected by special spectral characteristics and again it showed a higher number of counts at the above values of z. The amazing aspect of these observations is that this effect is seen at all, considering that it is normally assumed that most of the redshift measured is the result of expansion. Taking Equation (1) and adding a Doppler component (z_d) due to absolute motion of the source in addition to the expansion of the general matter distribution, we get

$$(1+z_0) = (1+z_i)(1+z_c)(1+z_d) \qquad (2)$$

For a unique value of z to stand out in a number distribution of QSOs, $z_0 \approx z_i$. Therefore $z_d \ll 1$ and $z_c \ll 1$. Normally, $z_d \leq 0.001$, therefore only a modest cosmological expansion term ($0.1 \leq z_c \leq 0.05$) would completely smear out the effects observed in the peaks. This forces the conclusion that these redshifts must be comparatively local objects. In fact, the conclusion is drawn that, when large data sets are taken, the smearing effects are caused by non-negligible cosmological redshifts (z_c).

Hoyle *et al.* present a table of QSOs, which are clearly associated with nearby active galaxies, as discussed previously. The redshift of the QSOs lie close to one of the peaks in the distribution explained above. However, it is also supposed that the measured redshift of the associated galaxy is the true cosmological component (z_c) where these are associated objects. Also it is assumed that there is a Doppler (z_d) redshift due to line-of-sight motion of the ejected QSO from

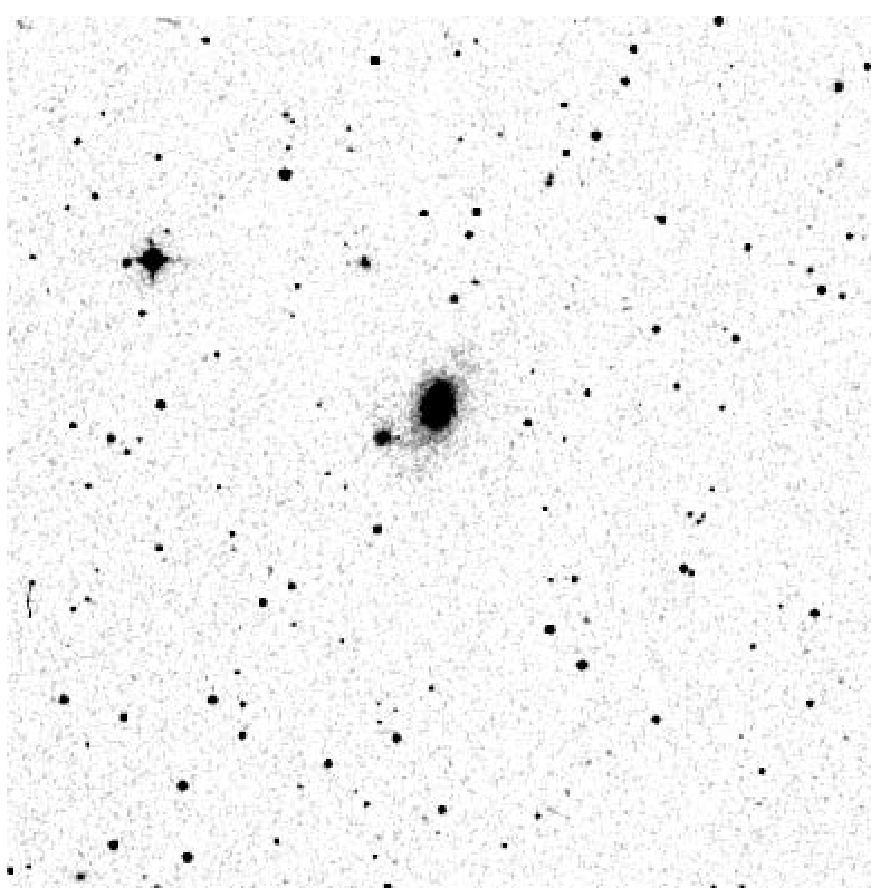


Photo by NASA, Space Telescope Science Institute, AAO, UK-PPARC, ROE, National Geographic Society, and California Institute of Technology.

Galaxy NGC 7603 in Pisces is a cosmic curiosity with discordant redshifts seen between the galaxy and its companion.

the parent galaxy. Both blueshifted and redshifted velocities (cz_d) are seen with magnitudes ≤ $0.1c$. From Equation (2) the intrinsic redshift (z_i) then may be calculated. When applied to the tabulated 16 QSOs, the resulting intrinsic z_i were the values 0.30, 0.60, 0.96, 1.41 and 1.96 listed above. This is quite remarkable in itself, and strongly indicates that the association of the QSOs and the parent galaxy is real.

Conclusion

The book by Hoyle *et al.* presents a cosmological model very different from the standard BB model. The book is a valuable resource of observational data and arguments against the standard BB cosmology.

For example, the issue of quantised redshifts is one that all varieties of cosmologists will have trouble with except the creationist. Ultimately the universe was designed and built by the One who made the atom and He chose to quantise energy on the atomic scale. Maybe the energy associated with the mechanisms in QSOs is also quantised, thus constituting the origin of this effect.

Does the fact that the book is published by Cambridge University Press mean that the long disfavour of the establishment is beginning to thaw? Is it possible that the SS model may one-day replace the BB model as the preferred cosmological paradigm? Perhaps, but it is too early to say. And if it does, what of those compromising evangelicals who have reinterpreted the Bible to make it fit the BB? No doubt, they will then argue that the Bible is really consistent with the SS model.

The SS cosmology is just one more version of a long-age evolutionary philosophy. In fact, it is more naturalistic than the BB model because it seeks to eliminate the philosophical problem of the BB—who lit the fuse that made the big bang?

A different cosmology? Not really. It's just the same philosophy of atheistic naturalism. Their aim is to explain the origin of the universe without acknowledging the existence or the work of the supernatural Creator God. Modern man cannot allow a divine foot in the door.

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