A New Cosmological Model?

by A.C. Sturt

The Royal Society held a one day symposium on 20 November 2013 in partnership with the Norwegian Academy of Science and Letters on 'Frontiers in Astronomy: from the beginning of the Universe to the outer reaches of the Solar System'.

During questions after the presentation on the implications of the Large Hadron Collider for cosmology, I pointed out one apparently unnoticed consequence: the results on the collision of heavy ions at relativistic speeds may be incompatible with the current cosmological model of the expanding Universe. The fact that the ions were reduced to smaller particles by the energy of their collision demonstrated that a similar process could occur naturally in stars. This note explains the analysis that led me to this conclusion.

There are three fundamental observations which are interpreted as evidence that the Universe is expanding. The first is redshift, which is considered to be caused by the stretching of wavelengths as galaxies recede from each other. The second and third are the observed abundance of elements and the cosmic microwave background which match the predictions of the expansion model. These are somewhat circular arguments because it cannot simultaneously be claimed that the cosmic microwave background and redshift are the result of the Big Bang and the expansion of the Universe, and that redshift and the cosmic microwave background are evidence that there was a Big Bang and the Universe is expanding. They are compatible, but there might be other explanations, as I have claimed elsewhere.

However, setting that discussion on one side, the expansion model of the Universe comprises progress from the notional original explosion through a succession of stages to an eventual cold, dark state when the lights have gone out because all the hydrogen available for fusion has been converted to metallic elements i.e. nuclear waste. This waste takes the form of bodies composed of rock flying apart for ever, because the process has no end.

The disintegration of heavy nuclei through collision demonstrates that this need not be the case. The products of disintegration will be hydrogen or small nuclear particles which can be built upon by fusion processes. In fact the Universe may be considered to be in a state of dynamic equilibrium without end, and by implication, without beginning. This alone is sufficient to call into question the interpretation of the other two indicators which depend on electromagnetic radiation, but they are not the subject of this paper. Suffice it to say that the state of dynamic equilibrium is timeless, and so it can give no indication of a lifetime of 13.7 billion years since the origin of the Universe, nor that indeed there was one, let alone a Big Bang.

A. The principle of dynamic equilibrium

It helps the analysis to illustrate the concept of dynamic equilibrium by reference to chemical science, in which it is a frequent phenomenon. A practical example is the decomposition of hydrogen iodide which occurs at 350ºC to form the elements hydrogen and iodine. The reaction never goes to completion, so that there is always hydrogen iodide left. If on the other hand, hydrogen and iodine are heated in equimolecular quantities at 350ºC, i.e. the reverse reaction, they form hydrogen iodide, but again it never goes to completion: there is always some hydrogen and iodine left. The reason is that a state is reached in which hydrogen iodide is being both formed from and decomposed into the elements at the same rate. Or alternatively, hydrogen and iodine are both being consumed by reacting together and formed by decomposition of the products at the same rate. When the hydrogen, iodine and hydrogen iodide are heated under these conditions, they will always form the same proportions of each, whether it starts with the elements or the compound. This is the 'equilibrium' in which the outcome as a whole gives the impression that nothing is happening, whereas at the level of the individual molecules they are always combining and decomposing. The overall state is apparently static because even small quantities of chemicals contain billions of molecules, and so the state of individual molecules is obscured. Hence a dynamic equilibrium. Provided nothing enters or leaves the system, and for chemical reactions temperature and pressure remain constant, it can go on indefinitely. In this condition it has no beginning and no end; it is 'timeless'.

Guldberg and Waage in 1864-7 found that the rate at which each component reacts is proportional to its molecular concentration or 'active mass'. It is now called the Law of Mass Action.

Dynamic equilibrium appears to be a fundamental principle for stability and control in many biological systems. The present analysis extends it to the particles of cosmology.

B. Cosmology

The basic hypothesis of science is that the stuff of the entire Universe is composed of subatomic particles combined in various proportions to form all the elements of the Periodic Table. If this were not true, scientific results would apply only in the local area in which they were obtained, which would make science meaningless in a wider context.

The signatures of the elements of the Periodic Table are seen in the spectra of stars. The conditions of temperature and pressure for the synthesis of elements are also those which are observed in stars. The process of nuclear fusion transmutes hydrogen into the next element in the Periodic Table, and then step by step into all the heavier metallic elements. The ultimate transmutation is into elements and compounds which form what are essentially inert rocks. In the expansion model, the Universe is eventually composed of such bodies plus residual hydrogen which by chance of location cannot collect to form the critical masses necessary for fusion. Expansion of the Universe means that these continue to fly apart for ever, because there is no end point. This is a one-way process driven by entropy.

However, colliders have shown that there is another possibility. Small particles including hydrogen can be formed by collision of the built up nuclei which could undergo fusion in their turn. In this case the relative abundances of metallic elements which we observe today in the Universe may be an equilibrium value. An equilibrium value gives no indication of time; it was the same a million years ago and a billion years ago. In fact once the process is in operation, the equilibrium could last for ever, even *ad infinitum*.

When we observe the Universe, we see that particles in stars are continuously being forced together by nuclear fusion to form nuclei with greater mass, but we have shown by experiment that these nuclei can also break up under the extreme conditions of colliders. Thus the process as a whole is a dynamic equilibrium. The constant condition of this equilibrium is the unchanging and unavoidable force of gravitational attraction between particles, which serves much the same function as temperature and pressure in dynamic chemical equilibria. Chemical reactions occur because molecules are contained by sufficient pressure to hold the particles with thermal motion in close proximity.

The conditions which cause opposing reactions may exist in stars. Certainly the common agreement is that metallic elements are formed by stars, because they are the only bodies with sufficient temperatures and pressures to force primary particles together. But stars are extremely turbulent with violent eruptions of material and strong magnetic fields, as observed in our own star, the Sun. These may be strong enough to cause collisions of nuclei with sufficient energy to smash them apart. It has also been discovered that some regions of space may be acting as particle accelerators.

C. The Universal model

Stars are mainly composed of hydrogen. Each star is in a state of dynamic equilibrium, according to the above analysis. However, stars come in a range of sizes and different colours, which indicate the degree to which nuclear fusion has transmuted each of them into metallic elements with the production of heat and light. The nuclear process is caused by the force of gravitational attraction which pulls the particles closer together and builds up pressures and temperatures, and so the dynamic equilibrium can be disturbed by the addition or loss of mass, because by definition this is what gravitational attraction acts upon.

If a star expels material and then regains it because the material remains within the reach of the star's gravitational attraction, the material will continuously fall back into the star and maintain the equilibrium. This is the star as an island. Some expelled material may remain suspended. However, if stars move with respect to each other, so that chance may bring some close enough for the gravitational attraction of one to drag material off another. This star then gains mass at the expense of the other. If a star actually collides with another body or even a star, the result is a greater mass. If a star reaches such a size that it explodes, this is the most drastic change of composition of all; its mass is spread across the Universe in various forms, and eventually incorporated into other stars. All of these changes disturb the equilibrium of a star and set it off on a new path, potentially with more or less nuclear fusion. The result is that these processes are continually leading to heterogeneity in the population of stars,

while the overall composition stays the same: a dynamic equilibrium driven by the force of gravity. There is no increase in the total quantity of stuff, just a redistribution.

The movement of stars is not hypothesis because they are in fact observed to be in measurable, ceaseless movement with respect to each other, ultimately driven by the force of gravitational attraction and the momentum which ultimately results from it. This gravitational force does not have to be in the same star to result in disturbance of its dynamic equilibrium, because the force of gravity has no cut-off distance. The stars simply have to be in the same Universe. It is just that changes of gravitational attraction resulting from changes of mass or distance take time to register throughout space, because they travel at the velocity of light *in vacuo*. The overall result is that the nuclear fusion which goes with the accumulation of mass in a star is transferred from star to star. The corollary of this is that the production of metallic elements is also transferred from star to star.

These are all stochastic processes dependent on chance, and they lead to a Universal equilibrium because local imbalances of mass are counteracted by opposite imbalances elsewhere. "Stochastic" is probably a better description than "random" because there is nothing random about gravitational forces; relentless would be more appropriate. In the course of time there is no way of building up a permanent imbalance in the whole system, because it equilibrates by redistribution. It is a question of time, of which there is as much as it takes. It is a system with thoroughly bad mixing from a human point of view, but cosmically it works. Similarly on the cosmic scale, there is no way for entropy to change, any more than the total quantity of matter can change by the above processes. This is dynamic equilibrium on a grand scale, where stars are 'particles' of the Universe.

There is another exchange between bodies in space in the form of electromagnetic radiation, which we tend to focus on because we can see it. But electromagnetic radiation is an indicator rather than a driver in this system. It is produced by the acceleration of electrons in the atoms of which the star is composed. Its loss does not affect the equilibrium of the star in itself, because it has no mass. Thus when it arrives at another star, it adds no mass, but simply increases the star's temperature a little, in fact very little by comparison with nuclear fusion.

D. Conclusions

A model of the Universe has been constructed which combines the hypothesis that the nuclei of elements are forged in stars and the fact that such nuclei can be smashed into primary particles in colliders. The result is a Universal dynamic equilibrium driven by the all-pervading forces of gravitational attraction. Such a model requires no beginning or end, simply perpetual redistribution of mass, which is neither created nor destroyed. Redistribution of mass is also redistribution of the potential for nuclear fusion. This is in direct contradiction to the current expansion model which started with a Big Bang and 'ends' in barren rocks and residual hydrogen.

It is the Large Hadron Collider which provides the evidence. The argument has been presented in terms of heavy ions, but it could have been protons, for instance, because

these are also being destroyed in the collider. Heavy ions are useful conceptually because we can envisage how they could be broken up and reformed, even if it is in stars. Nuclear synthesis is not possible by us. Synthesis of protons would take us into a whole new world of, one that is even less accessible since it involves primary particles which are mostly glimpsed in detectors, and are never likely to be synthesised into anything under conditions which we could create.

According to the new model, Big Bangs are occurring at various times all over the Universe, wherever there is a sufficient accumulation of mass, though this is not the only or perhaps even the main process of redistribution of mass. Much of the analysis of the Big Bang model would also be relevant to multiple Big Bangs. In this case what is described as the Big Bang itself would simply be a special, localised case of the physics of the whole model.

The relationship to the other 'proofs' of the Big Bang is clear. The redshift argument becomes: what colour would a sodium lamp have on alpha-Centauri? The answer must surely be that it would have the same colour as on Earth. In which case why is the colour redshifted when it reaches Earth? Something must happen in between the source and Earth, and I have proposed measurements to confirm it in a separate paper. As far as the cosmic microwave background is concerned, by the same analysis all radiation in transit in the Universe would eventually decrease in electromagnetic frequency to form a background at the microwave or even lower electromagnetic frequencies.

Nor does it encompass what seems to hold stars together in galaxies, though some stars seem to survive as individuals. Furthermore, there is another argument to be had on the nature of the primary particles which go to make up e.g. protons. Another of my papers suggests that there is really only one primary particle from which all others are made by sintering in various degrees, which is essentially an extension of the proposition of the present paper. I have called this the ε-particle because it has the mass of an electron without the charge. However that may be, these are elaborations of the present model. They do not affect the basic conclusion that the Universe is in dynamic equilibrium and infinite in time and space.

The fundamental hypothesis is that any physical phenomenon which can be created on Earth also occurs in the processes of the Universe. The suggestion that the Large Hadron Collider in some way outperforms the stupendous processes which occur in stars, even the small ones, is surely a miscalculation. The only processes which can lay claim to being unmatched in the Universe are those of life. Quite simply, particles and particle processes, however complicated to observe, are homogeneous through time, and so are the natural processes which relate to them. Living entities are not. That's life!

A.C.Sturt

28 November 2013