Equilibrium Cosmology

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In equilibrium cosmology (EC), the Universe neither expands nor changes globally in other respects, *i.e.*, it is in equilibrium. Theoretically, EC is based on the (empirically supported) strong ("perfect") cosmological principle (CP) and—as a consequence of the CP—electrogravitational coupling (EGC). The essence of and arguments for the EGC are summarized. EC divides into three fields: radiation and gravitation, connected via EGC, and research into equilibrium evolutionary processes (EEP), which in the CP-universe, ensure the properties of matter are unchanging, even though all individual systems evolve. The foundations and construction of EC are simple and coherent, and the CP-property makes it extremely sensitive to the empirical tests.

In radiation cosmology, the EGC explains the redshift effect with all its observed properties, including distance-dependent and distance-independent z's; in the former, varying steepness of the (r,z) relation depending on density is predicted and also observed. Cosmological redshift is a special case of the universal z-effect; EC predicts a unique (m,z)-relation, which is in form different but numerically coincides with the Hubble relation, which has depicted the observations well for six decades. The value of the Hubble constant is derived theoretically. The quantization of both the (cosmological) redshift of galaxies and intrinsic z of QSO's also follows from the theory.

The cosmic background radiation is a re-emission of the electromagnetic energy originating in galaxies and absorbed by EGC in the cosmological redshift. Its energy density, temperature, Planckian spectrum, photon-baryon number ratio, similarity with the local starlight energy density, and general isotropy are all derived from the EC-model. The predicted dipole anisotropy vector fits the observations well. In particular, it is emphasized that the reported extremely exact blackbody form of the spectrum and the still extreme isotropy of the CBR are firm fingerprints of a Universe in equilibrium, while these are implausible in the other models.

In gravitation cosmology, an explicit formulation of Mach's principle is first given. Following from a finite limiting value of the "Machian force" of cosmic masses, the solution of the Seeliger-Neumann gravity paradox is obtained. It appears that the Machian force ($a_c = G_c\rho/\alpha_c H \approx 10^{-8}$ cm s^{-2}) determines the structure in the Universe: uniform cosmological distribution, the transition to hierarchical local structure, and mass-to-size structure of supergalaxies, clusters, groups and individual galaxies. The gross internal structure and its evolution are derived, and the flat rotation curves of spiral galaxies are explained without hypothetical dark matter. The field equation defining EGC and equation of state joining the two long-range forces to large-scale structure are given.

Equilibrium evolutionary processes (EEP) are not examined in detail. The problem is to find, for galaxies (and stars) and their systems, and for the intergalactic background, those processes which establish physical parameters as invariant on the large scale, even though these are known to change locally. Important parameters are, *e.g.*, density distribution, rotation, morphological type, stellar populations, galaxy age and mass distributions, element abundances, and photon/baryon number ratio. Some preliminary discussion is presented. In all cases, processes in the diffuse cosmological background, those in the dense galactic nuclei, and, of course, stellar astrophysics, have important roles. It should be noted that, while Olbers' paradox is solved easily by the finite value of the integral of the redshifted radiation of the galaxies, this works only on the first level; the final solution will probably parallel the solution of the photon/baryon EEP problem. The whole problem of the EEP forms a new and extremely rich field for physical science, and will probably be the focus of research in the next century.

1. Introduction

For over two decades, the author has been involved in a project to test the cosmological expansion hypothesis in a systematic manner (Section 2). The results have been quite consistent: the Universe does not expand. Nor does it evolve globally in other respects. Consequently, the Universe must be in equilibrium, and this necessitates a corresponding theory.

Of course, this result destroys the standard big-bang theory of cosmology (ST). Nor does it it offer support to the classical steady-state cosmology (SST), which has been the main challenger of the ST for almost half a century. The distinguishing feature of the SST is the perfect cosmological principle, which is confirmed by the results in Section 2. Consequently, the new theory described here will be steady-state, though it will not be a static version of the classic SST. There is no expansion, while the theoretical basis is different. The cornerstone of the equilibrium cosmology (EC) will be the strong cosmological principle (CP, Section 3.i.); its physical foundation is not general relativity, as in ST and SST, but a hypothesis of electrogravitational coupling (EGC, Section 3.ii). Consequently, in most respects (*e.g.* as regards the redshift, microwave background, origin of baryonic matter, galaxies and light elements, solutions in the background paradoxes, *etc.*), the theory differs not only from the ST but also from the SST.

The general structure of the EC will be presented in Section 4. Its three components—radiation cosmology, gravitation cosmology and the search for equilibrium evolutionary processes (EEP)—will be outlined in the subsequent sections 5 through 7. The most obvious testing possibilities are pointed out in Section 8. The discussion in Section 9 deals with the status of ST, SST and the new theory.

All the sections below confront the reader with empirical or theoretical arguments which are quite new or controversial in the prevailing model. The only way to solve the dilemmas posed is by logical reasoning combined with careful analysis of observations specific to the problems. In particular due to the strong form of the CP, but also due to its theoretical conceptions, the theory presented appears to be an exceptionally testable theory. Perhaps the most intriguing—and most difficult—problem is that of the EEPs. This field of research is established by the most characteristic feature of the Universe which leads to a third cosmological paradox, analogous to the earlier paradoxes of Olbers-de Cheseaux and Seeliger-Neumann. It states: everything evolves, yet the whole does not evolve. Together with its associ-