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BOOK REVIEW

Julio A. Gonzalo: Cosmic paradoxes

World Scientific, Singapore, 2011, 134 p., Hardcover: USD72.00 GBP47.00, ISBN: 978-981-4355-61-2. Paperback: USD34.00 GBP22.00, ISBN: 978-981-4355-11-7

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To present cosmology alongside a number of paradoxes at first seems to be an amusing idea. Those used in this slim book of 120 pages are the well-known Olber's paradox, and others assembled by the author under the names "accelerating universe"-, "missing mass"-, "dark energy"-, and "baryon-to-photon ratio" paradox. On the book's cover, it is suggested that they are discussed "in depth with physical and logical content and historical perspective", and that the book "has not much technical content in order to serve a wide audience". In fact, there are only three to four places where calculations are performed which may be non-trivial to the less initiated.

The book starts with introductions to energy conservation (Chapters 1, 2) fundamental interactions, and relativistic cosmology (Chapters 6–8) interspersed with a discussion of Olbers paradox (Chapter 5). It is here that I raised an eyebrow because the physical discussion of energy conservation is accompanied with an attack on materialism (Haeckel) and a defense of Judeo-Christian, in particular Catholic, tradition. There are also two involuntary spiritual guides through the presentation, theoretical physicist Georges Lemaître and historian of science Stanley Jaki, both also catholic priests. In discussing the Friedmann–Lemaître solutions, the author claims that "assuming $k = 0$, $\Lambda \neq 0$ is fully equivalent to assuming $k = -|k| \neq 0$, $\Lambda = 0$" (p. 45). Here, k is the constant curvature of 3-space and Λ the cosmological constant. This surprising and unjustified narrowing of the set of models serves to introduce the author's favorite cosmological model: an expanding "open" universe ("open" meaning $k = -1$) "with a finite mass" M and $\Lambda = 0$. That the total mass of the universe is not an observable, remains as unmentioned as the fact that, in his model, the pressure of the cosmic substrate must vanish: $p = 0$. Actually, in his book the author leaves out alto-

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gether the second of Friedmann's equations without introducing as a helpful substitute $\dot{\rho} + 3\frac{\dot{R}}{R}(\rho + p) = 0$, where ρ is the energy density and R the radius of the universe. R is introduced on p. 5 as if it were an observable distance. Elsewhere, indeed a number of 9.96×10^{27} cm for the present value of R is given (p. 85). Essentially, the author imagines the universe as an expanding ball of matter with radius R "moving radially away from the center of gravity of the finite mass universe" (p. 65). A "cosmic Schwarzschild radius" $R_+ = \frac{2GM}{|k|c^2}$ is said to set the length scale of the universe (p. 46).

According to the author, Olbers paradox can only be removed by viewing it "in terms of cosmic finitude" (p. 32). With this, seemingly the finiteness of the total mass of the universe is meant again (p. 28); a connection to the limited age of the universe, of galaxies or stellar populations as suggested in other books on cosmology, is not made. The battle against "fundamental Marxist dogma" claiming "eternality and infinity of matter" continues. The other paradoxes are discussed in Chapters 10–12, where the author is anxious to show that his model with $\Lambda = 0$ is compatible with the data from cosmic background radiation (WMAP 2003). However, his values for the matter density- and curvature parameters in table 11.1 (p. 74) at redshift $z = 0$, i.e., $\Omega_m = 0.044$, $\Omega_k = 0.956$, are in disaccord with the present numbers from the ΛCDM-model as they are intended to be. A remark of S. Weinberg from 1977 to the effect that the baryon-to-photon ratio might be time-dependent is turned into a paradox. The conclusions from the one and only reference to more recent research given by the author (ref. 8 in Chapter 11, p. 76/77) in which the ΛCDM-model is questioned empirically, have not been accepted, generally. There are many more critical studies made within astrophysics.[1]

Despite the non-technical approach by the author, a use of his book for teaching cosmology to non-physics students cannot be recommended. There is too much looseness in it. To give just two examples: when the geometry of the universe is discussed, it is said that it "reduces to that of a set of two-dimensional surfaces describable by a single curvature parameter K". A relation between K and the 3-curvature k understandably is not made but, worse, $K = 0, \pm\frac{1}{a^2}$ is related to what is called "the scale factor a" (p. 39). Next, the definition $H = \frac{\dot{R}}{R}$ is called "Hubble's law" (p. 67) but the equation $H = cz$ is nowhere given. Hence I doubt that an equation like (10.2) on p. 67 for the relative recession velocity of an object can be easily understood. In fact, redshift is introduced as gravitational redshift in Chap. 6 (p. 39), but then used as cosmological redshift z in figure 7.1 (p. 51). A pecularity of the book is that its illustrations lack captions; my guess is that the picture below the likeness of A. Friedmann on p. 64 shows G. Lemaître and pope Pius XII.

In his foreword, the author professes to start from an honest conservative point of view, and defines this as not imposing a priori conditions. But this is exactly what he does: for personal reasons he opts for a universe with finite total mass from the beginning of his text (p. 7). Thus he gives away a position of calmly pointing to some debatable assumptions of present cosmological theorizing (inflationary model, role

[1] One among them being Craig. J. Hopi et al. "Large angle anomalies in the CBM". *Advances in Astronomy* **2010** (2010), Article ID 847541.

of inhomogeneities, unknown nature of dark energy/dark matter, quantum cosmology etc.)[2] in favour of a not well substantiated plea for a "contingent" and created universe (p. 87). In view of its shortcomings, it is doubtful whether this book can play a noticeable role in the spread of knowledge about the universe.

[2] Cf. my paper "What kind of science is cosmology", *Annalen der Physik* (Leipzig) **522**, Nr. 6, 389–418, 2010; arXiv: astro-phy/2010.5532.