Gravitation Essay

APPENDIX 3C

ARE QUASARS MERELY COMPACT, PULSATING STARS, RED-SHIFTED BY MACH'S PRINCIPLE?

by

Robert W. Bass
Professor of Physics and Astronomy
Brigham Young University, Provo, Utah 84601

ABSTRACT

Standard General Relativity (GR) shows that stable stars, no matter how compact, cannot have red-shifts z unless $0 < z < 2$. In the present theory (wherein it can be proved rigorously that complete gravitational collapse is impossible), the GR result $z < 2$ must be completely relaxed (to $0 < z < +\infty$).

Arguments based both upon theory (nonlinear, non-conservative stabilization of radial pulsations) and observations (scatter-diagram nature of quasar red-shift/magnitude relation) are presented to support the proposition that quasars are merely compact pulsating stars.

It has been shown elsewhere that abundant geophysical, astrophysical ($\gamma > 1$), and cosmological ($q < \frac{1}{2}$) evidence requires, with 95% probability, that standard General Relativity (GR) must be modified in a manner similar to but in essense exactly opposite to the Jordan, Brans, Dicke (JBD) theory, to include a variable Cavendish parameter G satisfying the two properties

$$\text{(1a)} \qquad (\delta G/G) > 0 , \qquad \text{(1b)} \qquad (\dot{G}/G) > 0 .$$

Here (1a) means that the value of G measured by two test-particles increases as the test-particles approach a ponderable mass, e.g., the Sun; a critical test onboard the Helios satellite (perihelion 1/3 AU, aphelion 1 AU) would be:

$$\frac{G_{per}}{G_{aph}} = \begin{cases} 1 + 0.9 \times 10^{-9} & \text{, present theory;} \\ 1 & \text{, GR;} \\ 1 - 1.3 \times 10^{-9} & \text{, JBD} \end{cases}$$

Similarly, (1b) means that G increases as cosmic time t increases, e.g., there is a Milne-type relation

$$\text{(3)} \qquad G \propto c^3 t/M , \qquad (0 < t < +\infty)$$

where M denotes essentially the rest-mass of the visible universe.

It has also been shown elsewhere that, in the present theory, complete gravitational collapse is impossible, i.e., black holes do not exist.

However, the present theory would not markedly affect the known criteria [cf. Misner, Thorne and Wheeler (1973) or Weinberg (1972)] for radial instability of oscillations of a radially pulsating star, since, far from the Laplace-Schwarzschild radius $r_{LS} = 2GM/c^2$, gravity behaves as in GR. In particular, Bondi's proof that a stable star of mass M cannot have a radius $R \leqq (9/8)r_{LS}$ probably remains qualitatively correct.

What happens, then, to a massive star whose mass exceeds the Chandrasekhar and Oppenheimer-Volkoff limits?

In the present theory there are, a priori, only two possibilities: either the radial pulsations increase without limit (explosive instability), or they reach an amplitude at which the exact nonlinear theory (including non-conservative effects, such as core shrinkage by increasing G, which augments nuclear transmutation as an energy source) is discrepant with the standard (linearized, conservative) stability analyses [cf. Harrison, Thorne, Wakano, Wheeler (1965)].

In the latter case, the star's light could be regarded as emitted from an average surface radius R, with fluctuations in luminosity L attributed to the nonlinear radial pulsations.

In standard GR, Bondi's relation

(4) $$R > (9/8)r_{LS}$$

implies [cf. Weinberg (1972), p. 334] that the maximum red-shift z satisfies

(5) $$z < 2,$$

and there is a large concentration of quasars with $z \cong 1.95$. However, quasars with red-shifts greatly exceeding (5) are also known.

What would be the red-shift, in the present theory, of light emitted at a distance R from the center of mass M, as perceived at infinity? From standard theory,

$$z = \frac{\delta\nu}{\nu} = -1 + \left\{\frac{g_{oo}(+\infty)}{g_{oo}(R)}\right\}^{\frac{1}{2}} =$$

$$= -1 + [B(R)]^{-\frac{1}{2}} =$$

$$= -1 + \frac{(1 + \beta/R)^{(|\omega| - 2)\delta}}{(1 - \alpha/R)^{(|\omega| - 2)\gamma}} =$$

$$= r_{LS}/2R \quad + \quad \cdots \quad (R \to +\infty) \,,$$

where the positive [non-PPN] parameters (α, β, γ, δ) are explicitly known rational functions of the dimensionless coupling constant $|\omega| > 2$, such that, e.g., $\alpha\gamma + \beta\delta \equiv 2r_{LS}/(|\omega| - 2) \overset{d}{\doteq} \varepsilon$, and, as $|\omega| \to +\infty$ (where GR is recovered) $\alpha \to r_{LS}$, $(\beta/\varepsilon) \to 0$, $\delta \to (2|\omega| - 2)^{-1}$, $\gamma \to (2|\omega| - 2)^{-1}$. Thus, in the present theory, by (6)

$$0 < z < +\infty, \tag{7}$$

i.e., *every possible red-shift is allowed*.

It is to be expected that there will be a random distribution of possible values of R, hence of possible values of z, which should, therefore, resemble a *scatter-diagram* rather than follow Hubble's red-shift/magnitude relation. Hoyle and others have commented that the observed red-shifts of quasars do indeed resemble a scatter-diagram, as shown in Figures 1, 2. Therefore, the basic prediction of the present theory is confirmed by observational evidence.

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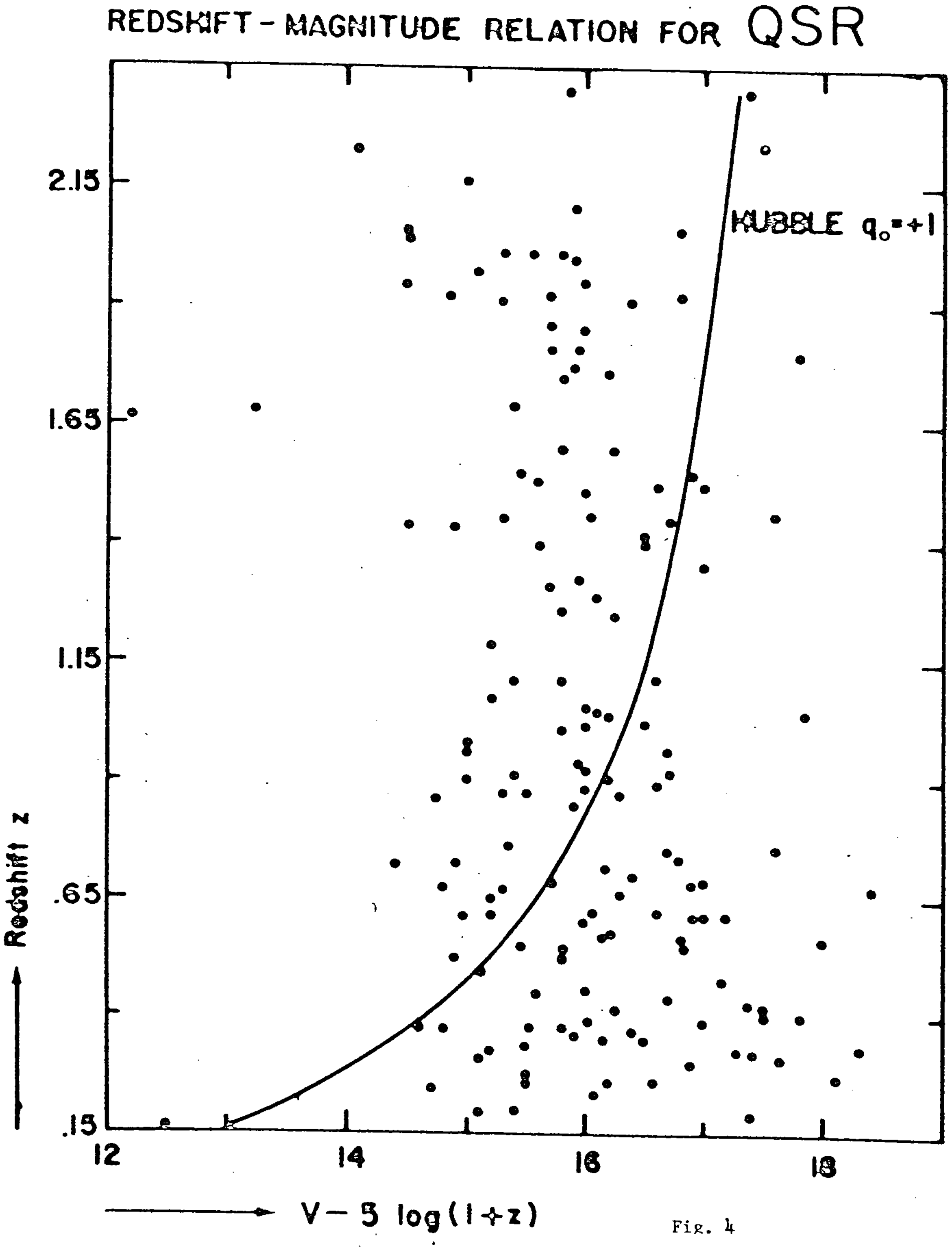

Figure 1

After Hoyle (1972), taken from Field, Arp and Bahcall (1973)

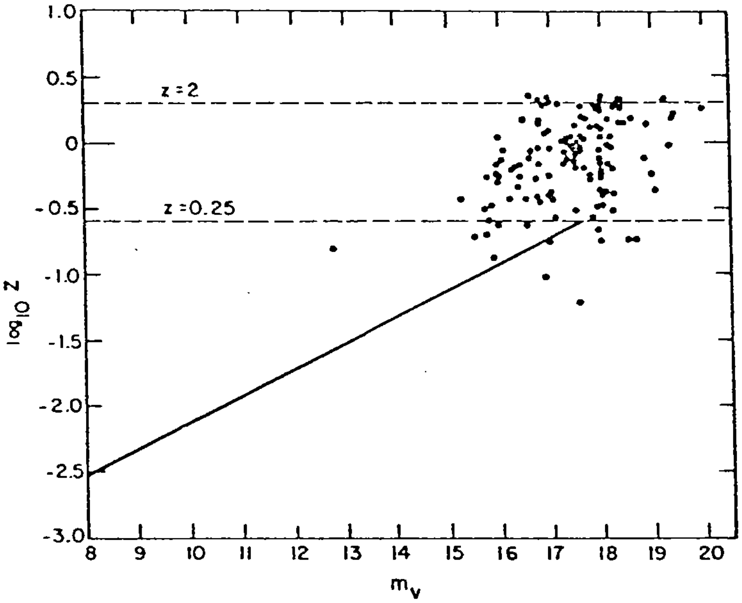

Fig. A.8 Red-shift–apparent visual magnitude relation for all QSO's with $z = \Delta\lambda/\lambda$ known in 1969. Note the difference between this plot and Fig. 2.4 (after Burbidge and Burbidge, Bu69).

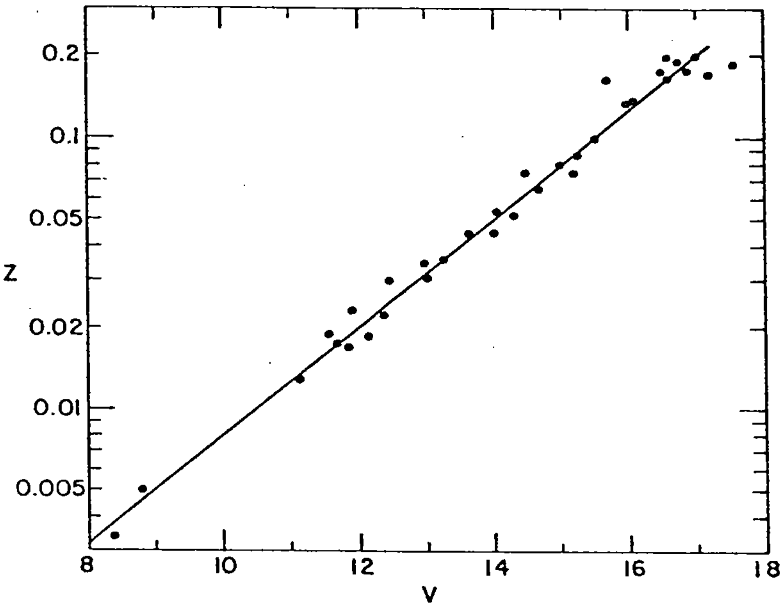

Fig. 2.4 Red-shift–magnitude diagram for the brightest members of 38 clusters of galaxies. After J. V. Peach (Pe69) based on data obtained by A. Sandage. z is the red shift $\Delta\lambda/\lambda$. V is the visual magnitude.

Figure 2

After (a) Burbidge & Burbidge, and (b) Peach with Sandage, taken from from Harwitt (1973)