SELECTION OF COSMOLOGICAL MODELS USING QSOs

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Abstract. It is assumed that the QSOs are at cosmological distances as indicated by their emission-line redshifts. It is further assumed, as indicated by present evidence, that none of the 21 QSOs with emission-line redshifts, z_e, of 2.0 ± 0.1 (or of the 30 with $z_e = 2.0 \pm 0.2$) is screened by an intervening normal galaxy. The simplest conclusion from these data is, then, that the screening probability must be less than 0.08 (or 0.06) at $z_e = 2.0$. This, in turn, restricts allowable cosmological models in the (σ_0, q_0) diagram by providing lower limits for σ_0 as a function of q_0. One can also rank cosmological models in order of the probability that there be no screening of the 21 (or 30) objects. In either case the steady state model ranks higher than the general relativity models found by Peach to give the best fit in the $(m - z)$ diagram.

It seems now to be reasonably certain that the absorption lines in the spectra of QSOs are not due to the screening of the objects by intervening galaxies (Shuter and Gower, 1969; Heiles, 1970). The statistical test outlined by Bahcall and Peebles (1969) has been extended and carried out in several cosmological models and indicates also that the absorption-line redshift systems do not seem to be occurring at random between ourselves and the various objects (Roeder, 1970). This evidence, together with the radio data mentioned above, and the fact that several observers have detected absorption lines in the spectra of the nuclei of Seyfert galaxies, strongly indicates that the absorption-line phenomenon is produced at the object and not somewhere in the line of sight. It will therefore be assumed that no object is being screened by an intervening galaxy.

In some cosmological models, however, the probability that at least one object of the 21 with $z_e = 2.0 \pm 0.1$ or 30 with $z_e = 2.0 \pm 0.2$ (see Figure 1), will be screened, is quite high, so that these models are then in conflict with observation and can be ruled out. In particular, if N represents the number of objects, and pr is the probability of screening at $z_e = 2.0$, (Roeder and Verreault, 1969), then we should have

$$Npr - \left(Npr(1 - pr)\right)^{1/2} < 0.5$$

so that no object will be screened. Thus, if $N = 21$, $pr < 0.081$: if $N = 30$, $pr < 0.060$. The screening probability for $z_e = 2.0$ can be computed for any cosmological model given the values of σ_0 and q_0 using the methods outlined by Roeder and Verreault, and hence the loci of $pr = 0.08$ and $pr = 0.06$ can be drawn in the model diagram as shown in Figure 2.

Models to the left of the iso-probable contours of Figure 2 are not compatible with the observed lack of screening of QSOs at $z = 2.0$. It is interesting to note that both of the general relativity models ($\sigma_0 = q_0 = 1.54$ and $\sigma_0 = 3.79$, $q_0 = -0.41$) found by Peach (1970) to give the best fit in the $(m - z)$ diagram satisfy the above-noted criteria.

If one wishes to go further he can take acceptable models with $pr < 0.081$ or $pr < 0.060$ at $z = 2.0$ and rank them according to the probability that none of the 21 or

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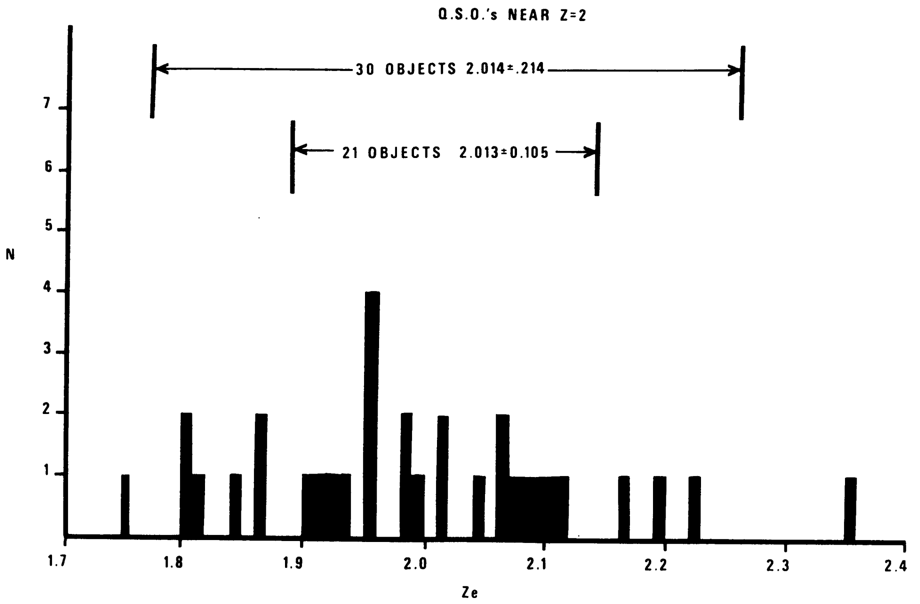

Fig. 1. Histogram of emission redshifts near $z = 2$ for QSOs.

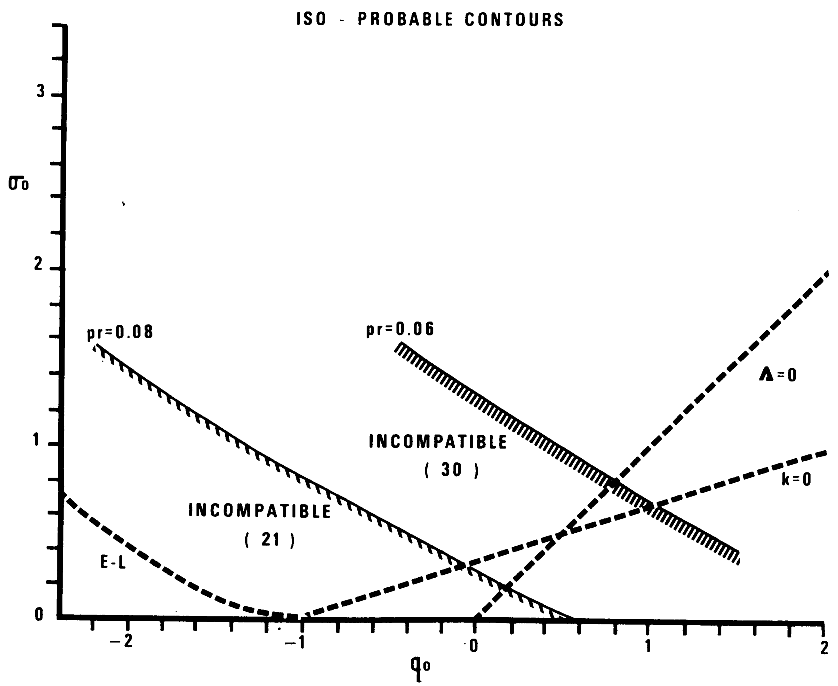

Fig. 2. Compatibility of cosmological models with condition for absence of screening.

30 objects at $z = 2.0$ shall be screened. This probability is easily computed using the binomial distribution, and the results are shown in Table I.

TABLE I
Probabilities of no screening at $z = 2.0$

σ_0	q_0	21 objects	30 objects
0.0268	-1.2066	1.9×10^{-4}	4.8×10^{-6}
1.0	1.0	0.294	0.174
1.54	1.54	0.348	0.222
3.79	-0.41	0.386	0.257
Steady state		0.560	0.437

Interestingly, of all the models listed there, the steady state model has the highest probability. Even the simple closed Friedman model with $\sigma_0 = q_0 = 1.0$ is, however, compatible with the observations. The Lemaître model with $\sigma_0 = 0.0268$ and $q_0 = -1.2068$ does not seem to be very likely from Figure 2 or Table I. Indeed, all Lemaître models with the cosmological constant very nearly equal to its critical value would appear, according to the simplest application of these ideas, to be very unlikely to represent the observed universe.

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