ARE VOIDS PRESENT IN THE LYMAN-ALPHA FOREST?

Arlin P. S. Crotts
McDonald Observatory, University of Texas
Austin, TX 78712 U.S.A.

SUMMARY: If voids like those seen in the low z galaxy distribution existed in the H I distribution at $z \approx 2$, then high quality QSO spectra, with many Ly-α forest lines per unit z, could be used to discern the voids from the usual random fluctuations in observed number density of lines ($\equiv n$). Several such spectra have been obtained, and these show evidence for gaps in the Ly-α distribution on scales of 20 to 50 h^{-1} Mpc (comoving coordinates, with $h = H_0 / 66.7\ km\ s^{-1}\ Mpc^{-1}$, assuming $q_0 = 0.1$). These results are summarized in the table below. All QSO spectra with a line-of-sight n of Ly-α lines $n > 80$ *per unit* z and total number of lines $N > 40$ known to the author are included (except that of PKS 2000-330 [c.f. Carswell and Rees 1987], which is broken into five separate segments of Ly-α forest by gaps in the data and a broad absorption line). Excluded are portions of these spectra where n falls more than 25% below the mean due to instrumental bias. For each of these the distribution of gaps between nearest-neighbor Ly-α redshifts is computed as a function of gap size. If the distribution of redshifts were Poisson, the distribution of gaps should be a decreasing exponential function of gap size. For the two best spectra, large deviations from an exponential are found in the range of 20 to 50 h^{-1} Mpc (in the other four cases, it should be noted that a large number of gaps of such sizes are still expected from Poisson fluctuations). The probability that such deviations are statistically consistent with an exponential distribution is shown in the fifth column of the table.

TABLE: DEVIATION OF GAPS IN THE LYMAN α FOREST FROM THE RANDOM EXPECTATION FOR SIX CASES OF HIGH QUALITY QSO SPECTRA

QSO	N	Δz range considered	n (*per unit* z)	Random prob. P	Nature of deviation	Ref.
0420-388	125	0.656	204	0.005	Large gap, 42 h^{-1} Mpc	1
1225+317	60	0.404	149	0.10	7 gaps > 20 Mpc, versus 3 if random	2,4
1623+268	46	0.315	143	> 0.1	Consistent with random	3
0453-423	44	0.411	107	> 0.1	Consistent with random	4
2126-158	59	0.628	94	> 0.1	Consistent with random	4
0002-422	47	0.553	85	> 0.1	Consistent with random	4

References: 1) Atwood *et al.* 1985, 2) Bechtold *et al.*, 3) Sargent *et al.* 1982, 4) Sargent *et al.* 1980.

The one clear case, in 0420-388, is summarized elsewhere (Crotts 1987, Carswell and Rees 1987). Be aware, however, that even this gap may contain marginally detected lines, with column densities $n_{H\,I}$ on the order of 10^{13} cm^{-2}. Increasing the sensitivity threshold (also increasing n) until the gap is split, the new probability estimate is $P \lesssim 0.02$ (this is difficult to state prcisely without better data). These results indicate the probable existence of a population of voids in the H I density at $z \approx 2$, but voids larger than 20 h^{-1} Mpc fill less than 20% of all space. This is inconsistent with the filling factor for voids in the low z galaxy distribution, on the order of 90% (de Lapparant *et al.* 1986). Obviously more data are needed to clarify the question of the frequency of such voids.

REFERENCES

Atwood, B., Baldwin, J. A., and Carswell, R. F. 1985 *Ap. J.*,**292**, 58.

Bechtold, J., Green, R. F., York, D. G., Weymann, C. R., Foltz, C. B., Chaffee, F., Price, C., and Shectman, S. *in preparation.*

Carswell, R. F., and Rees, M. J. 1987 *Mon. Not. R. astron. Soc.*, **234**, 13p.

Crotts, A. P. S. 1987 *Mon. Not. R. astron. Soc., in press.*

de Lapparent, V., Geller, M. J., and Huchra, J. P. 1986 *Ap. J.*, **302**, L1.

Sargent, W. L. W., Young, P., Boksenberg, A., and Tytler, D. 1980 *Ap. J. Suppl.*, **42**, 41.

Sargent, W. L. W., Young, P., and Schneider, D. P. 1982 *Ap. J.*, **292**, 58.

J. Audouze et al. (eds.), Large Scale Structures of the Universe, 569.