THE EVOLUTION OF QSO SPECTRA:

Evidence for Microlensing?

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Abstract. We find that the spectra of QSOs evolve: high redshift QSOs ($z > 1.5$) have lower equivalent width emission lines than low redshift QSOs ($z < 0.5$) with the same luminosities and radio properties.

We propose that microlensing by compact objects may account for the apparent evolution. If $\Omega \sim 0.05$ in compact objects, the continuum emission from many high redshift QSOs will be amplified, but not the line emission, leading to the observed decrease in the apparent equivalent widths.

1. Introduction

If much of the missing mass of the universe is in the form of compact objects, it will microlens distant QSOs. If the compact objects have masses comparable to the Sun, their Einstein radii will be comparable in angular size to the continuum sources of the high redshift QSOs. The microlensing can thus strongly amplify the continuum emission from QSOs, but emission coming from more extended regions, such as the emission-line radiation, will not be amplified. Thus abnormally low ratios of emission-line to continuum flux (ie. low equivalent widths) are a signature of microlensing.

Canizares (1982) and Delcanton et al. (1994) showed that for $\Omega \sim 0.05$ in compact objects, many bright high redshift QSOs will be appreciably microlensed, and would show reduced emission-line equivalent widths.

C. S. Kochanek and J. N. Hewitt (eds), Astrophysical Applications of Gravitational Lensing, 289–290.

2. Our Study

We compared the spectra of low redshift ($z < 0.5$) QSOs, drawn from the IUE archives, with those of high redshift ($z > 1.5$) QSOs drawn from the Large Bright QSO Survey (Morris et al. 1991). The samples were carefully matched in luminosity, radio loudness and rest-frame wavelength coverage; see Francis & Koratkar (1995) for details.

3. Results

We see evolution: the mean equivalent width of the Ly-α and C IV emission line is significantly lower in the high redshift sample than in the low redshift sample, as predicted by the microlensing model. The details of the equivalent width distributions also match the microlensing prediction; the change in the mean equivalent width is caused by an increase in the fraction of QSOs having very low equivalent widths at $z > 1$.

For more detail, see Francis & Koratkar (1995).

4. Conclusions

The spectra of QSOs evolve, and the form of the evolution can be explained by microlensing by a cosmological population of compact objects with $\Omega \sim 0.05$. However, we have no way of ruling out intrinsic evolution in QSO spectra, which could also explain our result.

References

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