GRAVITATIONAL LENSES AND DAMPED LY-α SYSTEMS

A. SMETTE
Kapteyn Astronomical Institute
Postbus 800, NL-9700 AV Groningen, The Netherlands

J.-F. CLAESKENS
E.S.O. (Chile) and Aspirant au FNRS (Belgium)
Institut d'Astrophysique, Université de Liège
5 Avenue de Cointe, B-4000 Liège, Belgium

AND

J. SURDEJ
Directeur de Recherches au FNRS (Belgium),
STScI, 3700 San Martin drive, Baltimore, MD 21218, USA

Abstract. We study the influence of gravitational lensing on determinationing the number density and column density distributions of damped Ly-α systems.

1. Results

Systems showing damped Ly-α absorption lines seen in quasar spectra (hereafter, DLAs) are thought to arise in the progenitors of present day disk galaxies (Wolfe 1988) and contain at least a large fraction if not all of the neutral hydrogen content of the Universe at high-z (Lanzetta, Wolfe, Turnshek 1995). Statistics of DLAs are based on the assumption that the lines-of-sight towards background quasars are distributed uniformly over the sky and thus are unaffected by the DLAs themselves.

However, gravitational lensing (GL) provides three effects that undermine this assumption (Smette 1995):

– the 'by-pass' effect: a random line-of-sight has its effective impact parameter increased relatively to the case when no lensing is taking place;

C. S. Kochanek and J. N. Hewitt (eds), Astrophysical Applications of Gravitational Lensing, 99–100.

https://doi.org/10.1017/S0074180900231033 Published online by Cambridge University Press

– amplification bias (due to the galaxy associated with an observed DLA as a whole): a set of quasars selected on the basis of their (bright) apparent magnitude is likely to contain a significant fraction of quasars whose apparent brightness has been boosted by GL amplification;
– micro-lensing amplification bias: similar, but due to stars in the DLA.

We studied the two first effects and performed statistical tests devised to check whether existing surveys of DLAs are affected by GL. We assumed that the DLAs are the only GL agents, that they arise in spiral galaxies, immersed in dark matter halos, and can be described by a simple model.

The by-pass effect (function of the background QSO redshift z_q) may decrease by more than 20% the effective cross-section of the galaxies for DLA absorption; furthermore, their central part is avoided. Because of the amplification bias (function of z_q and QSO magnitude b_q), DLAs corresponding to an impact parameter equal to twice the Einstein radius of the host galaxy are preferentially observed in DLA surveys. These two effects may lead to severely over-estimate the number of DLAs with high-column densities at low-z (say in the range 0.3-0.6) in front of bright ($b_q < 17$), $z_q > 1$ quasars (Smette, Claeskens & Surdej 1995).

However, the existing DLA surveys have characteristics, specially at high-z, that may preclude the detection of strong GL effects:

– DLAs can be detected even in relatively low S/N spectra: thus faint QSOs can be used, for which the amplification bias does not work well;
– for high-z_q QSOs, the redshift range in which DLAs are searched for is limited to a redshift domain just somewhat smaller than z_q.

Indeed, we find that the high-z ($z > 1.6$) survey (Lanzetta et al. 1991) is not significantly affected by GL. However, if the IUE ($z < 1.6$) survey (Lanzetta et al. 1995) only detects 3 DLAs, they all lie in regions of the (z_{DLA}, b_q, z_q) domain for which the strongest GL effects are expected. No definite conclusion can be drawn due to the paucity of data, but HST direct imagery of the 3 background QSOs may reveal the signature of strong GL effects in the form of multiple QSO images and should thus allow to set unique constraints on the mass of the DLAs. Bartelmann & Loeb (these proceedings) have independently presented a similar work.

References

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