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Optical Counterparts to Damped Lyman Alpha Systems

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Abstract. Previously we have shown (Maller et al, 1998) that the kinematics of Damped Lyman Alpha Systems (DLAS) as measured by Prochaska and Wolfe (1998) can be reproduced in a multiple disk model (MDM) if the gaseous disks are of sufficient radial extent. Here we discuss this model's predictions for the relationship between DLAS and Lyman break galaxies (LBGs), which we here take to be objects at $z \sim 3$ brighter than $\mathcal{R} = 25.5$. We expect that future observations of the correlations between DLAS and LBGs will provide a new data set able to discriminate between different theoretical models of the DLAS. Djorgovski (1997) has already detected a few optical counterparts and more studies are underway.

1. Summary

We have used the Semi Analytic Models (SAMs) of Somerville & Primack (1999) to determine the distribution of galaxies in a dark matter halo, and the amount of cold gas in each galaxy. The SAMs also contain the star formation history of each galaxy so we can explore the optical properties of the galaxies in the halos that give rise to DLAS. Here we present results on the optical counterparts from the two models discussed in Maller (1999), in which we matched the kinematic data with thicker and less radially extended, or thinner, more radially extended gas disks. We show both models here only to demonstrate that the optical properties are not highly sensitive to the details of the gas modeling. We only refer to optical counterparts that reside in the same virialized halo that produces the DLAS. The contribution of LBGs in neighboring dark matter halos will be explored in future work, but is expected to be relatively unimportant.

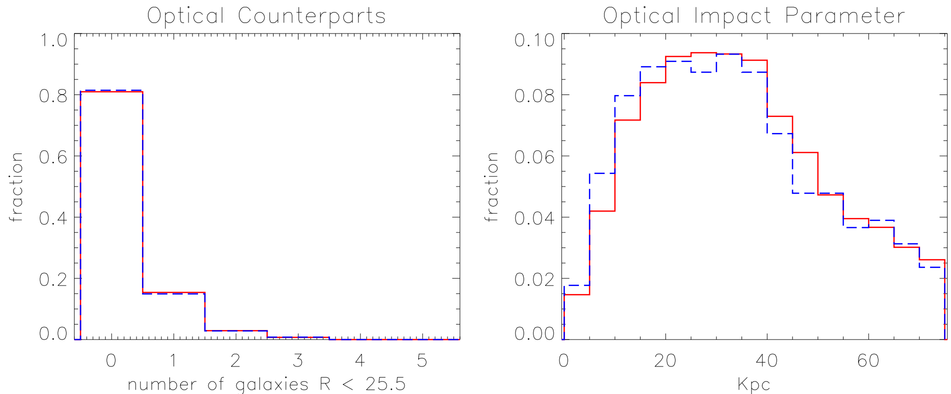

Figure 1. a) The distribution of the number of optical counterpart of DLAS. b) The distribution of optical impact parameters. In both panels the solid line is the thicker gas disk model, while the dashed line is for the thinner gas disks.

The properties of the optical counterparts will place strong constraints on DLAS models. One constraint is the number of DLAS with optical counterparts. Figure 1a shows the distribution that we see in our models. Eighty percent of DLAS do not have an optical counterpart with $\mathcal{R} < 25.5$, while a rare five percent contain two or more such galaxies in the same halo. Lastly we show the distribution of optical impact parameter (Figure 1b) in our models. The optical impact parameter is the physical distance between the line of sight to the quasar and the centroid of the light distribution of the LBG. We obtain a broad distribution of optical impact parameter values in our model. Because of the large radial extent of our gas disks, the DLAS are often many stellar disk scale lengths from the center of the light distribution. Also in the MDM scenario, with many galaxies in a single halo, sometimes the galaxy bright enough to be identified as an optical counterpart is not one of the galaxies giving rise to the DLAS: in this case very large separations are possible. Thus we expect the predictions about the optical impact parameter to be unique to the multiple disk model, and a useful way of distinguishing it from other models.

References

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