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DWARF GALAXIES: NEARBY PROBES OF THE DISTANT UNIVERSE

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RESUMEN

Basándonos en imágenes en el óptico y en H I de SBS 1543+593, una galaxia a $z = 0.009$ que se encuentra en la dirección del QSO HS 1543+5921 con $z = 0.807$, llegamos a la conclusión que las galaxias con bajo brillo superficial podrían ser responsables de las líneas de absorpción anchas de Lyα detectadas en espectros de cuasares.

ABSTRACT

Based on optical and H I imaging of SBS 1543+593, a galaxy at $z = 0.009$ which is seen along the line of sight towards the high redshift QSO HS 1543+5921 ($z = 0.807$) , we argue that low surface brightness galaxies could be responsible for the Damped Lyα lines which are seen in quasar spectra.

Key Words: **COSMOLOGY: OBSERVATIONS — GALAXIES: HIGH–REDSHIFT — GALAXIES: INDIVIDUAL (SBS 1543+593) — QUASARS: ABSORPTION LINES**

1. INTRODUCTION

It often proves difficult to connect what is seen at high redshift to what we know to exist in the local volume. A case in point are the Damped Lyα line systems (DLAs) which are seen along lines of sight towards distant QSOs. Column densities of the DLAs are defined to be $N(\mathrm{H\,I}) \geq 2\times10^{20}\,\mathrm{cm}^{-2}$. They usually show low ionisation metal lines, and because of this, they are thought to originate in large (proto–) spiral galaxies (Wolfe et al. 1986) or in thick, spinning galaxy disks (Prochaska & Wolfe 1997; 1998). Alternatively they may be due to clouds falling into the halos of galaxies (Haehnelt et al. 1998) during their construction. On the other hand, DLAs which are close enough to have been imaged by ground–based telescopes or with *HST* represent a "mixed bag", including low surface brightness galaxies and even dwarf galaxies (e.g., Le Brun et al. 1997).

Of the few objects which potentially are close enough to allow direct imaging, the best one to date is SBS 1543+593 which is located at a redshift $z = 0.009$. This low surface brightness galaxy intercepts the light coming from a QSO which was discovered by Reimers & Hagen (1998). These authors found that the QSO listed as HS 1543+5921 lies at a redshift of $z = 0.807$ and almost coincides with the center of the foreground object, its line of sight passing within $2.4''$ of its nucleus.

2. OBSERVATIONS

In the optical, the intervening object has been imaged by Bowen et al. (2001a) with *HST*. An *STIS* spectrum shows the characteristic signature of a DLyα line. The derived neutral column density is $2.2 \times 10^{20}\,\mathrm{cm}^{-2}$. A single dish H I spectrum shows a clear 21 cm detection (Bowen et al. 2001b). The total mass of H I corresponding to SBS 1543+593 is $1.3 \times 10^9\ \mathrm{M}_\odot$. Unfortunately the QSO is radio quiet, so no direct comparison could be made between the absorbing UV column density and that due to H I.

As the intervening object is so nearby, H I emission maps could be obtained, both with the GMRT (Chengalur & Kanekar 2002) as well as by us with the NRAO[4] VLA. Our map, which agrees broadly with the data presented by Chengalur & Kanekar is shown in Figure 1. The VLA maps differ from those of Chengalur in that our data cover a larger field of view. This has led to the detection, at $15.9'$ due East of our target, of H I emision corresponding to a galaxy classified as MCG+10–22–038 (≡ SBS 1545+593 ≡ CGCG 297–029) at a redshift of $2687\ \mathrm{km\,s^{-1}}$ versus $2865\ \mathrm{km\,s^{-1}}$ for SBS 1543+593. Our data also show the existence of two other faint galaxies in the field; these are barely detected on Digitized Palomar plates, and have no catalogued designations. Their existence points to a loose group in which SBS 1543+593 resides.

3. RESULTS AND DISCUSSION

Several independent observations indicate that DLAs are associated with low surface brightness galaxies (LSBs). Obtaining direct observations of the absorber is hard, though. H I observations would be hard pressed to detect emission of LSBs beyond a redshift of $z = 0.1$. In the case of SBS 1543+593

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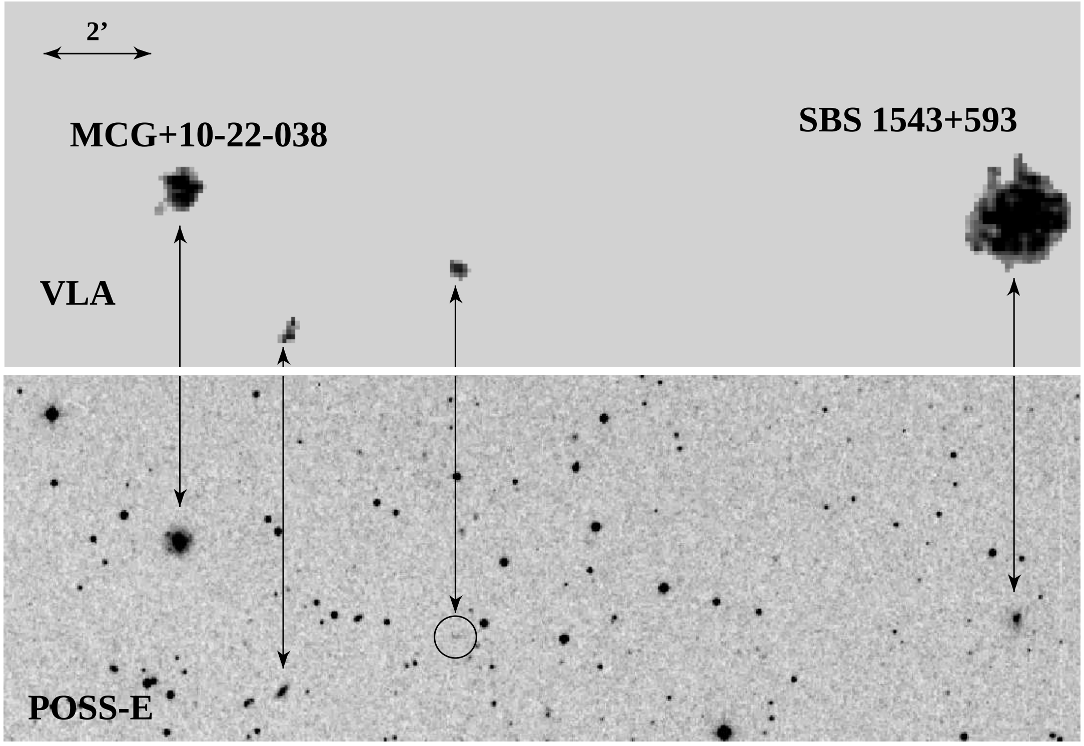

Fig. 1. VLA surface brightness map in the 21–cm line of neutral hydrogen towards SBS 1543+593, compared to a POSS-E digitized sky image. The angular resolution of the 21 cm map is about 15″

this limit is even less, at $z = 0.03$.

Another interesting aspect of our VLA data is the fact that they reveal companion galaxies at about the same redshifts. If anything, companions must have been more numerous at large lookback times. The H I column density of MCG+10–22–038 is comparable to that of SBS 1543+593 so it could give rise to a similarly broad DLyα feature. Hence, this strengthens the argument that low surface brightness objects might constitute an important fraction of the objects causing DLAs.

In addition to MCG+10–22–038, the two smaller companions of SBS 1543+593 might be good candidates as well for being associated with DLAs. In general, dwarf galaxies have column densities and metallicities which are within the canonical range for DLAs, although they tend to be lower than those found in regular spirals. An argument which has often been used to rule out a major contribution by dwarf galaxies is that they are small, supposedly flattened systems, offering a small cross section only. However, as has been shown by Walter & Brinks (1999), dwarf galaxies have puffed–up disks, increasing substantially their cross section and making it independent, to first order, to inclination. Considering that dwarf galaxies are the dominant population in the local universe and were more numerous at larger lookback times, it is to be expected that many DLAs could be due to dwarf galaxies.

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