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ORIGINAL ARTICLE

More on the narrowing of impact broadened radio recombination lines at high principal quantum number

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Abstract Recently Alexander and Gulyaev have suggested that the apparent decrease in impact broadening of radio recombination lines seen at high principal quantum number n may be a product of the data reduction process, possibly resulting from the presence of noise on the telescope spectra that is not present on the calculated comparison spectra. This is an interesting proposal. However, there are serious problems with their analysis that need to be pointed out. Perhaps the most important of these is the fact that for principal quantum numbers below $n = 200$, where the widths are not in question, their processed generated profile widths do not fit the widths of the processed lines obtained at the telescope. After processing, the halfwidths of the *generated* and telescope profiles must agree below $n = 200$ if we are to believe that the processed generated linewidths above $n = 200$ are meaningful. Theirs do not. Furthermore, we find that after applying the linewidth reduction factors found by Alexander and Gulyaev for their noise added profiles to our generated profiles to simulate their noise adding effect, the processed widths we obtain still do not come close to explaining the narrowing seen in the telescope lines for n values in the range $200 < n < 250$. It is concluded that what is needed to solve this mystery is a completely new approach using a different observing technique instead of simply a further manipulation of the frequency-switched data.

Keywords Galaxies: Cosmology: distance scale · Galaxies: Distances and redshifts · Galaxies: quasars: general

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1 Introduction

The theory of impact broadening of radio recombination lines was developed by Griem (1967). A broader coverage was carried out by Gordon and Sorochenko (2002) and radio recombination lines have been a valuable tool for many years for the purpose of studying the physical conditions inside galaxies (Gordon 2008). Using the frequency switching observing technique we have found evidence that the impact broadened linewidths of hydrogen recombination lines near 6 GHz appear to become much narrower than predicted at high quantum numbers, $n > 200$ (Bell 1997, 2011; Bell et al. 2000, 2011). Although a possible explanation for this was suggested by Oks (2004), this was refuted by Griem (2005). It was later demonstrated by Bell (2011) that when observations at other radio frequencies were taken into account the line narrowing appeared to be correlated with the density of recombination lines in frequency space. More recently Hey (2012) has obtained results that may eventually provide a theoretical explanation for the discrepancies seen between what the impact broadening theories predict and what has been observed in these high-n Rydberg-Rydberg recombination spectra from Galactic HII regions.

Because the multiple overlap data reduction technique we used requires special processing, it has recently been suggested by Alexander and Gulyaev (2012) that the narrowing at high n may be related to the processing. After generating theoretical impact broadened line profiles for Orion, these authors claim for the zone between $\Delta n = 11$ to 14 (near 6 GHz) that after noise is added to the generated profiles their processed lines exhibit a line narrowing similar to what was reported by Bell et al. (2011) as being a mystery. Here we examine their treatment of the data and find, unfortunately, that there appear to be some discrepancies that make their conclusion much less convincing than it appears to be at first glance.