Spectral lines – Radio Recombination Lines

Extended Radio recombination line emission with ALPACA Survey - ERAS

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Radiative and mechanical feedback from massive stars are major ingredients of galactic ecosystems. Photons from massive stars with energies above 13.6 eV ionize hydrogen creating HII regions, and, on a much larger scales (~ 50 pc to a few kpc), likely power the ionization of the warm ionized medium. The Galactic disk is a prime laboratory to study stellar feedback, as the majority of the massive stars in the Galaxy reside in it, and these are the closest massive stars we can study in detail. Radio recombination lines (RRLs) provide a unique tool to study stellar feedback, since these are extinction free kinematical tracers of ionized and neutral gases. Recent surveys of RRLs in hydrogen (HRRLs) in our Galaxy have revealed the ubiquity of ionized gas in the inner Galaxy, however they lacked the sensitivity and latitude coverage to explore how the ionizing radiation travels to the Galactic halo. Observations of HRRLs at 1.4 GHz offer a unique alternative to study the disk/halo connection because at this frequency RRLs from diffuse gas become brighter than at higher frequencies. Thus we propose to carry out a survey of the inner Galaxy with an extended latitude coverage ($-5^{\circ} < \ell < 32^{\circ}$ and $|b| \leq 3^{\circ}$, compared with the GBT Diffuse Ionized Gas Survey with $|b| \leq 0.5^{\circ}$), the Extended Radio recombination lines with ALPACA Survey (ERAS), to study the effects of stellar feedback on the ionized and neutral gases – through observations of hydrogen and carbon RRLs –, how the ionizing radiation escapes to the Galactic disk, and determine the hardness of the ionizing radiation – by comparing HRRLs and HeRRLs. Using the ALPACA receiver it will be possible to carry out this survey with 200 hrs of GBT time (covering the same area with the single pixel L-band receiver on the GBT would require 900 hrs). ERAS targets four RRLs around 1680 MHz with a 4 km s^{-1} spectral resolution, complements the GBT Diffuse Ionized Gas Survey (GDIGS) and GDIGS-Low surveys, enabling an accurate determination of the gas physical conditions, and improves upon the Parkes telescope 1.4 GHz HRRL survey by providing a factor of two better angular resolution and a factor of five better spectral resolution, crucial to provide a more accurate view of the gas morphology and kinematics.