Mapping [O III] Emission in Diffuse Ionized Gas

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Introduction

The Wisconsin H-Alpha Mapper (WHAM) has measured a variety of optical emission lines for a multitude of large-scale ionized regions that include loops, filaments, and bubbles. The results from such studies provide insight into the workings of these discrete structures as well as the warm ionized medium (WIM) that pervades the Galaxy. With the unique design of its 15-cm dual-tube Fabry-Perot spectrometer, WHAM has produced spectra of diagnostic lines such as [S II] λ6716, [N II] λ6583, and [O III] λλ5007 (e.g., Madsen et al. 2006; Haffner et al. 1999). Due to its faint-emission levels, [O III] in diffuse Galactic environments has not yet been studied in depth compared to prior work on [S II] and [N II]. Notable discussions on [O III] include Reynolds (1995), which discusses the first detection of faint [O III] emission from the WIM, and more recently Madsen et al. (2006), which presents deep observations of the line toward several selected directions. With longer integrated sightlines, [O III] in edge-on galaxies has been studied a bit more. Ott et al. (2002, 2005), Collins & Rand (2001), and Tillmann & Dettmar (2000) are a few of these recent studies of multiple emission lines, including [O III], in the diffuse ionized gas halos of edge-on galaxies. Here, we present the first kinematic (o) map of the [O III] of the Lockman Window (9° × 18°) to 205°, b = -17° to -6° as well as initial results toward two high-latitude sightlines, the region around HD 93521 (O9 V) and the Lockman Window.

Data

The data for this project were obtained during 2005 and 2006 with WHAM in a spectral mapping mode identical to that used for the Northern Sky Survey (NSS), but with the spectral window tuned for [O III] and with s integration exposures per one-degree pointing. See Haffner et al. (2005) for details. The “raw” data presented here have been flat-fielded and partially corrected for atmospheric extinction. Intensities are accurate to about 10% and the velocity scale has been calibrated to about 1 km/s.

To explore the behavior of [O III] emission in diffuse environments where emission is typically quite faint, we need to carefully characterize the atmospheric line emission within the [O III] spectral window. For adding terrestrial emission from the spectrometer to the background level (green dotted line). The orange dashed line shows how the fit would change with the addition of a single Gaussian having parameters \( v = 0 \) km/s and \( \lambda = 10 \) mR at the background level (green dotted line). The orange dashed line shows how the fit would change with the addition of a single Gaussian having parameters \( v = 0 \) km/s and \( \lambda = 10 \) mR.

Future Work

Our results here for the [O III] region will be made more robust by directly measuring the Hα/Hβ through the region. We have not corrected for extinction in the results presented here. In addition, He I λ5876 maps will also be produced to further probe the ionization structure of the nebula. Line emission from [O III] and [N II] for this region has been studied in a separate work (Haffner et al. 2007, in prep). With this relatively complete diagnostic line picture, comparing the emission profiles to photoionization models should offer a unique insight into the physical conditions throughout this diffuse, ionized region. Data from outside of the H II region itself will allow us to begin a more thorough study of [O III] in the WIM and may reveal changes in the ionization structure throughout the medium.

References