



The Ionization Source of and Distance to the Magellanic Stream

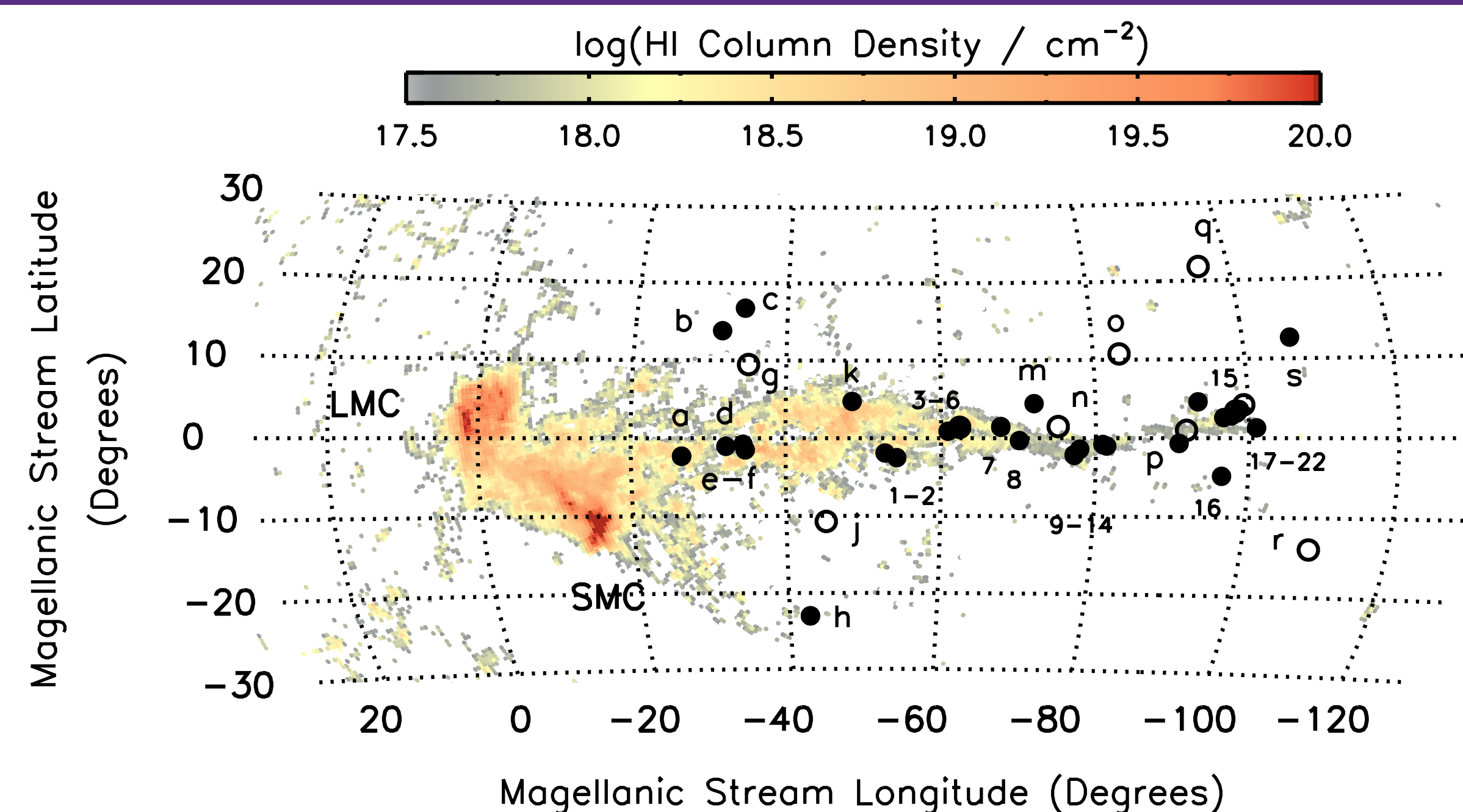
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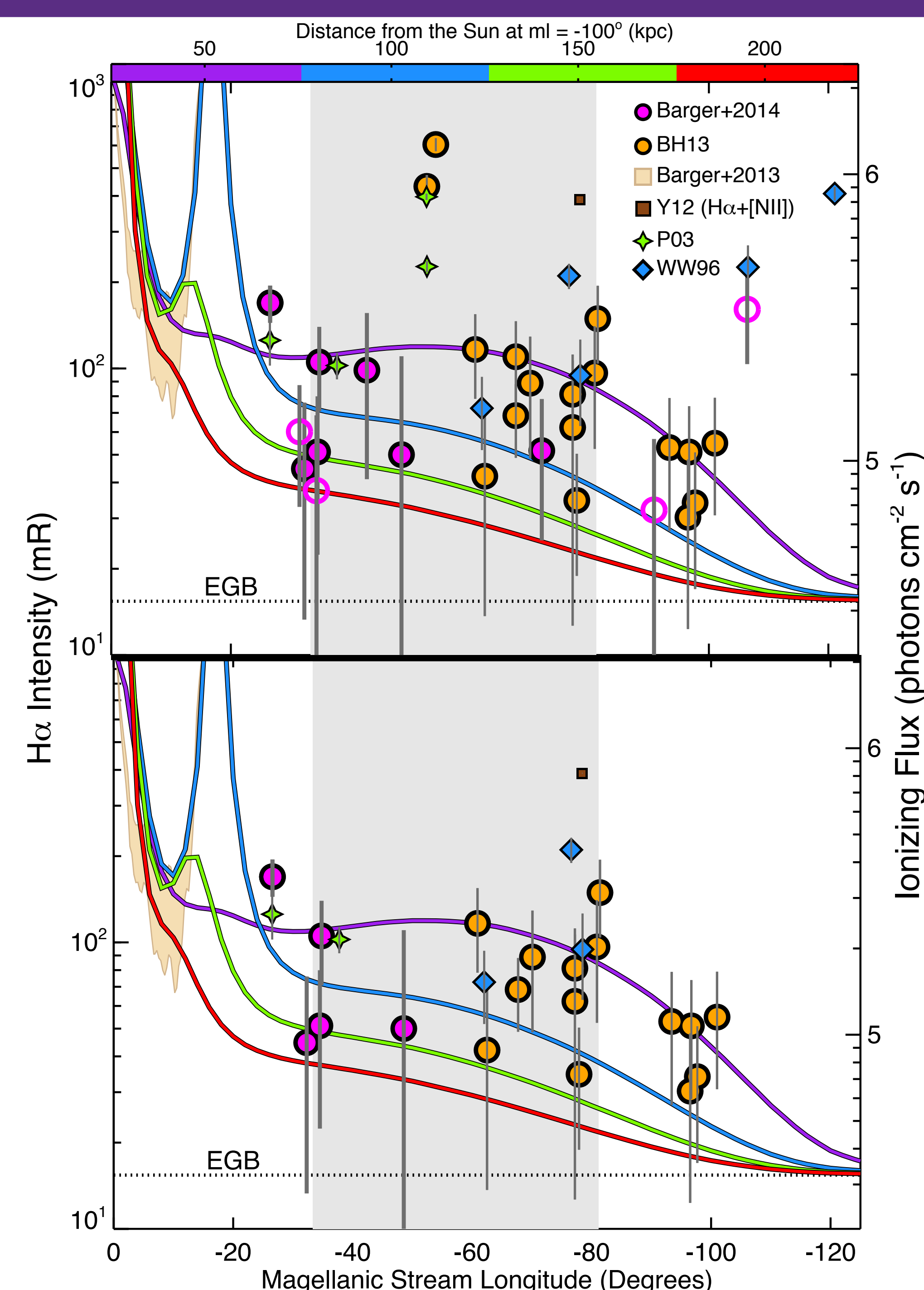
The nearby, tidally disturbed Magellanic Cloud galaxies have lost a tremendous amount of gas, which now lies in tidal streams that span over 200° across the sky. These gaseous streams are falling onto the Milky Way and could provide a substantial amount of material for producing stars if it can survive the journey to the Galactic disk. Interactions with the Galactic halo and the surrounding Lyman continuum can cause this gas to evaporate in transit by heating and ionizing it.

In this study, we constrain the distance of the Magellanic Stream at 100° from the Magellanic Clouds to be $d \geq 50$ kpc from the Sun when comparing the amount of H α emission that would be produced at different positions by the ionizing radiation field emanating from the surrounding galaxies. This places a lower mass limit of $M \leq 2 \times 10^9 M_\odot$ for the total gas contained in all of the Magellanic tidal debris (Fox et al. 2014).



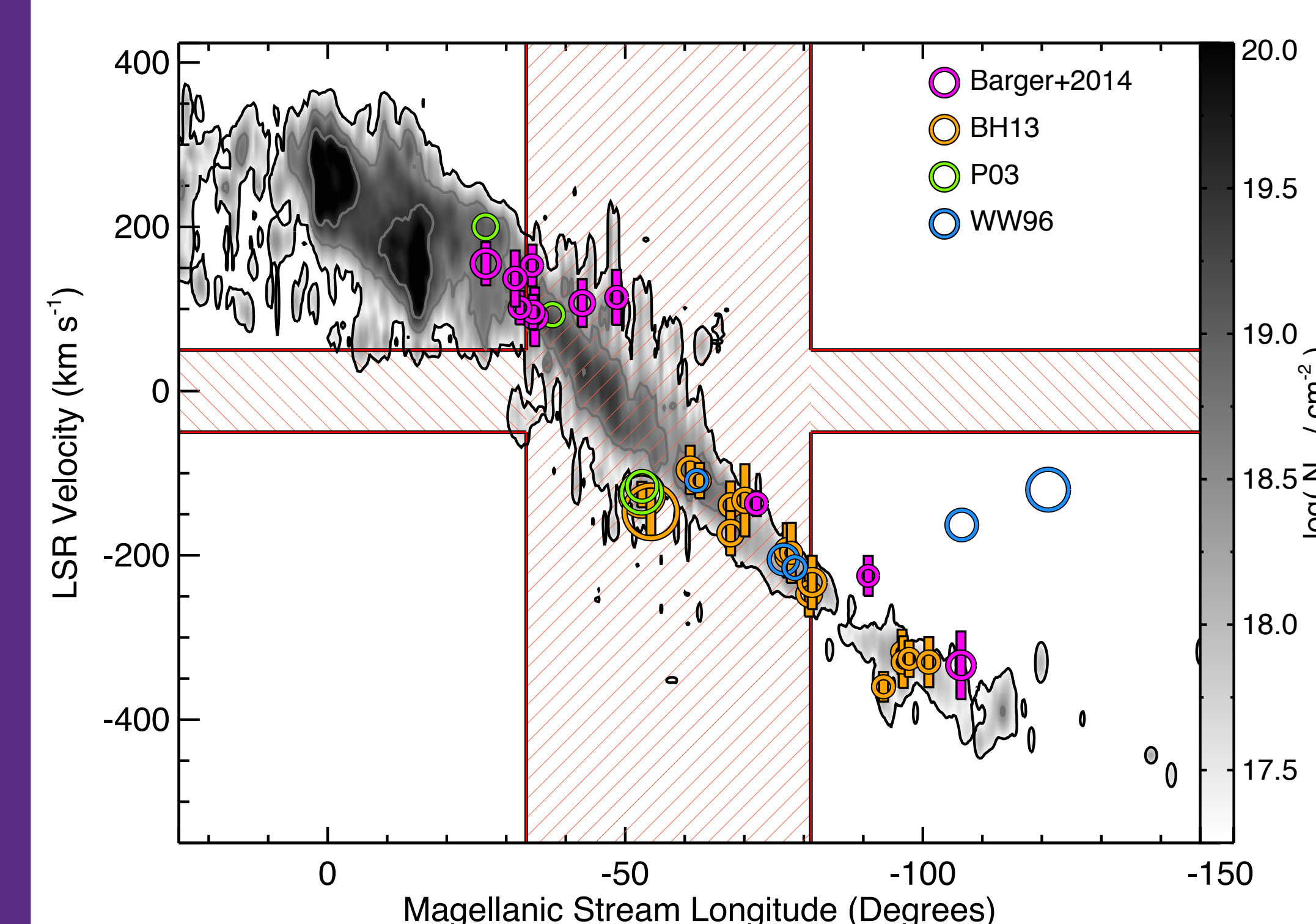
The Location of pointed Wisconsin H α Mapper telescope observations along the Magellanic Stream. The background H I column density gas map is comprised of Gaussian decompositions fits to the Leiden-Argentine-Bonn (LAB) all-sky survey that has been adapted from Nidever et al. (2008).

This H α emission extends more than 2° off the H I emission. We find that the ionization fraction of the Stream increases as N_{HI} decreases. Regions with $\log N_{\text{HI}}/\text{cm}^{-2} \approx 19.5-20.0$ are 15–65% ionized, based on comparisons of the [O I] and H α emission. These ionization fractions closely agree with those found in the Fox et al. 2014 absorption-line study, implying very little ionization changes on $< 1^\circ$ scale.



The H α intensity for sight lines on and off (Top) and only on the H I filament of the Magellanic Stream. The right-hand y-axis marks the amount of ionizing photons needed to reproduce observed H α emission. The colored solid lines trace the predicted ionizing flux from the MW (Fox et al. 2005), MCs (Barger et al. 2013), and EGB (Haardt & Madau 2001) at different distances that are anchored at the Magellanic Clouds to 50–200 kpc at an angular distance of 100° from these galaxies. Some of the observations below the South Galactic Pole are too bright for these photoionization sources alone; energetic processes associated with the Galactic center might also influence them (Bland-Hawthorn 2013).

The sight lines positioned off or on the edge of the Magellanic Stream tend to have higher H α intensities than those that aligning with high H I column density gas. The spectral profiles at these positions are often offset from the H I gas emission by as much as 30 km s⁻¹. We conclude that these low H I column density sight lines are less shielded from the surrounding coronal gas and ionizing radiation field and are likely evaporating into the Galactic halo.



Position-velocity diagram of the H α detections along the Magellanic Stream. The background map traces the positions of H I velocity components from the Nidever et al. 2008 Gaussian decomposition fits. The points are colored the same the middle figure. The extent of the vertical colored bars signifying the width of the line and not the uncertainty of the velocity. The red shaded regions span where the Stream is below the South Galactic Pole (vertical) or where its velocity crosses that of the MW disk (horizontal).

WW96: Weiner & Williams 1996; BH13: Bland-Hawthorn et al. 2013
P03: Putman et al. 2003; Y12: Yagi et al. 2012 (H α + [N II])

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