Study of the Interstellar Medium and Cosmic Rays in local H I Clouds

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Aims. We aim to study the interstellar medium (ISM) and cosmic-rays (CRs) in a mid-latitude region in the third Galactic quadrant (Galactic longitude \( l \) from 200° to 260° and latitude \( |b| \) from 22° to 60°). The region is expected to be dominated by local H I clouds since it is located at high latitude and free of large molecular clouds.

Methods. We evaluated the total gas column density \( N(\text{H}_{\text{tot}}) \) by investigating the correlations among 21 cm survey data (HI4PI), Planck dust thermal emission models (optical depth at 353 GHz \( \tau_{353} \) and radiance \( R \)), and Fermi-LAT \( \gamma \)-ray data in the region studied. In the South region, we first masked areas containing an intermediate velocity cloud or the Orion-Eridanus superbubble, and that with a ratio of the integrated H I 21-cm line intensity to dust emission significantly different from that seen in the rest of the region. We then fit the \( \gamma \)-ray data with a linear combination of gas template maps based on Planck dust models and other components to obtain the total gas column density \( N(\text{H}_{\text{tot,}\gamma}) \).

Results & Prospects. We found that \( N(\text{H}_{\text{tot,}\gamma})/\tau_{353} \) and \( N(\text{H}_{\text{tot,}\gamma})/R \) depend on dust temperature \( T_d \) in the North region, indicating that that neither \( \tau_{353} \) nor \( R \) were proportional to \( N(\text{H}_{\text{tot}}) \). We also found that \( N(\text{H}_{\text{tot,}\gamma}) \) is not proportional to \( \tau_{353} \) but shows non-linear relation in the South region. We will examine the systematic uncertainties and discuss ISM and CR properties inferred from \( \gamma \)-ray data.

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