VARIABILITY OF THE COSMIC-RAY IONIZATION RATE IN DIFFUSE MOLECULAR CLOUDS

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The energy spectrum of cosmic-rays — a product of particle acceleration and subsequent diffusion — is generally assumed to be uniform throughout the Galaxy[a]. As a result, the cosmic-ray ionization rate inferred in similar environments (e.g. in several diffuse clouds) should also be relatively constant. However, current estimates of the ionization rate in diffuse molecular clouds vary over the range $(1 - 8) \times 10^{-16}$ s^{-1}. In addition, there are a few sight lines with 3σ upper limits of $\zeta_2 < 1 \times 10^{-16}$ s^{-1}, suggesting even lower ionization rates in some clouds. This roughly order of magnitude difference in the cosmic-ray ionization rate between sight lines contradicts the concept of a spatially uniform cosmic-ray flux.

We present cosmic-ray ionization rates derived from several published[bc] and unpublished spectroscopic observations of H_3^+ in diffuse cloud sight lines. These ionization rates are then compared with various other parameters (Galactic latitude, Galactic longitude, hydrogen column density) in a search for correlations. Also, sight lines in close proximity are compared to each other to determine the variability of the ionization rate on small spatial scales.

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[a] Webber, W. R. 1998, ApJ, 506, 329

[b] Indriolo, N., Geballe, T. R., Oka, T., & McCall, B. J. 2007, ApJ, 671, 1736

[c] McCall B. J., et al. 2002, ApJ, 567, 391