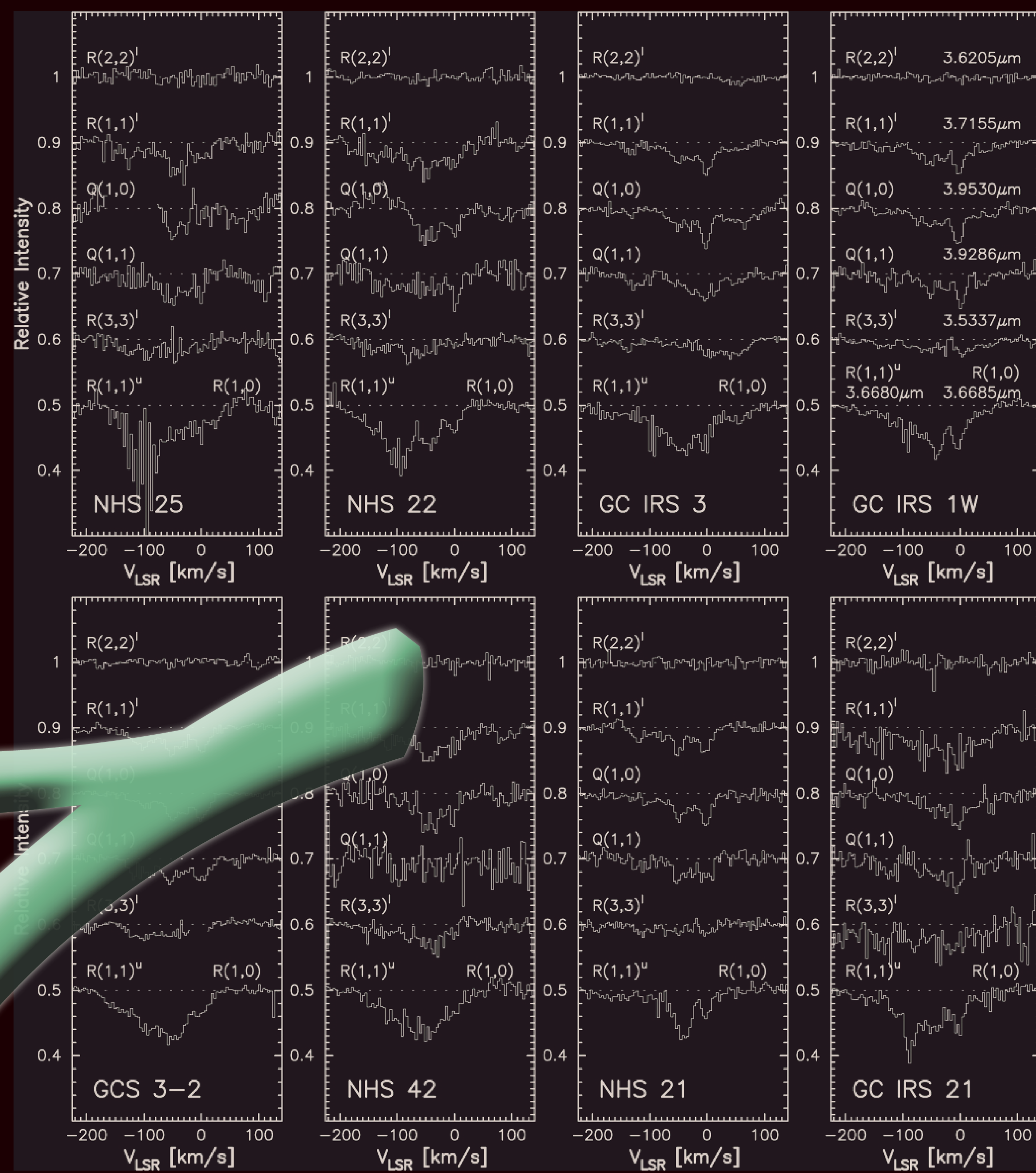
The abundance of H_3^+ in the diffuse clouds is controlled by two processes: the formation of ionization of H_2 by cosmic rays, and dissociative recombination by the electron.

$$H_2 + CR \longrightarrow H_2^+ + CR$$
$$H_3^+ + e \longrightarrow 3H \text{ or } H_2 + H$$

In the steady state, the number density of H_3^+ is given by $\zeta\, n(H_2) = n(H_3^+)\, n_e \cdot k_e$, where ζ and k_e, is the cosmic ray ionization rate and the rate constant of dissociative recombination with the electron. The column density of H_3^+ therefore gives the product of ζ and the dimension of the cloud in the radial dimension as $\zeta L = N(H_3^+)\, n_e / n(H_2)\, k_e$.



The column density of H_3^+ toward the Galactic center is $N(H_3^+) = (2\text{-}6) \times 10^{15}\ cm^{-2}$. If we take the cosmic ray ionization rate $\zeta = 2 \times 10^{-17}\ s^{-1}$ measured locally in the solar system, it gives the radial dimensions of the absorbing clouds over 1 kpc, that exceeds well beyond the boundary of the central molecular zone.

The ionization rate therefore must be as high as $\zeta = 10^{-15}\ s^{-1}$ in the Galactic center (Oka et al. 2005, ApJ, 632, 882), although we still have no clues as to what is the additional source of ionization.

The relative column density of H_3^+ in (J, K) = (1,1), (2,2) and (3,3) tells that the H_3^+ in the Galactic center is in highly non-thermal rotational distribution. This makes H_3^+ a good thermometer and a dentiometer (Oka & Epp, 2004, ApJ, 613, 340). The recent detection of $R(2,2)^l$ toward GC IRS 3 in the central cluster indicates that the cloud in front of the source, M -0.02-0.07 ("50 km s^{-1} cloud"), is hot [$T(H_2) = 450$ K] and diffuse [$n(H_2) = 200\ cm^{-3}$] (Goto et al. 2007, in prep).

Cosmic ray Ionization Rate in the Galactic Center

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