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158μm [CII] Mapping of Galaxies: Probing The Atomic Medium

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Previous observations of the 158 μm [CII] line toward the nuclear regions of external, gas rich spiral galaxies have shown that this far-infrared line alone contributes up to 1% of the total far-infrared luminosity, and that it arises from photodissociation regions (PDRs) formed on the surfaces of molecular clouds by the UV radiation from massive OB stars (Crawford *et al.*1985; Stacey *et al.* 1992).

Using the MPE/UCB Far-infrared Imaging Fabry-Perot Interferometer (FIFI) on the Kuiper Airborne Observatory (KAO), we have made large scale maps of [CII] in the spiral galaxies NGC 6946, NGC 891, M83 and the peculiar elliptical Cen A, thus allowing for the first time, detailed studies of the spatial distribution of the FIR line emission in external galaxies.

We find that the [CII] emission comes from a mixture of components of interstellar gas. The brightest emission is associated with the nuclear regions, a second component traces the spiral arms as seen in the nearly face on spiral galaxies NGC 6946 and M83 and the largest star forming/HII regions contained within them, and another extended component of low brightness can be detected in all of the galaxies far from the nucleus, beyond the extent of CO emission.

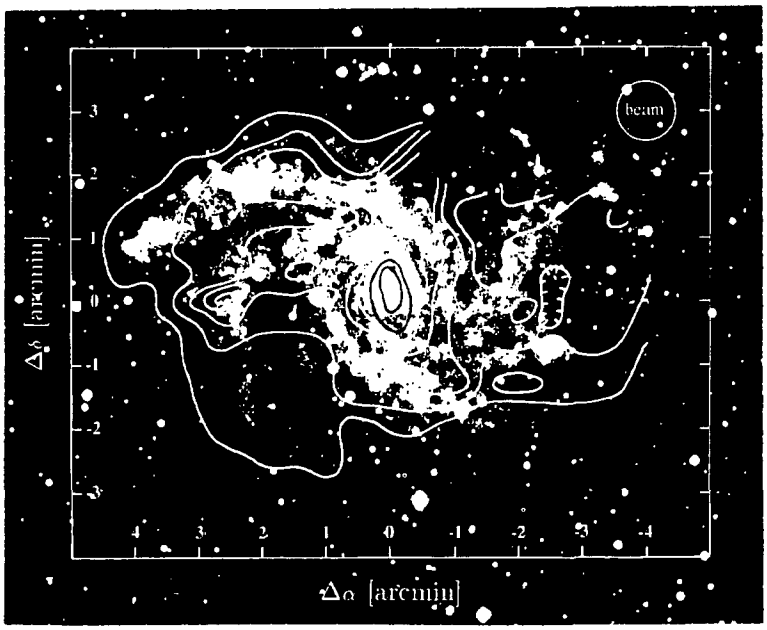

Figure 1. Integrated [CII] line intensity contours of NGC 6946 superposed on an optical image. The contour intervals are 1×10^{-5} erg $s^{-1}cm^{-2}sr^{-1}$ and the peak value is 7×10^{-5} erg $s^{-1}cm^{-2}sr^{-1}$. (Madden *et al* 1992).

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The nuclear and spiral arm components are most likely associated with dense (n(H)$\geq$ $10^3 cm^{-3}$) photon-dominated regions (PDRs) at molecular cloud surfaces that are exposed to ultraviolet radiation produced by young massive stars. We interpret the extended component as originating in the diffuse atomic (HI) medium, representing the first detection of far-infrared line emission from atomic interstellar gas. The extended [CII] emission probably originates mainly in cold (T$\sim$100 K), neutral hydrogen clouds having a pressure between 6.0×10^3 and 1.0×10^4 cm^{-3} K, similar to HI clouds in our Galaxy. Low density HII regions also contribute about $\sim$25% of the extended [CII] emission. Hot (T$\sim$8000K) diffuse HI gas can only significantly contribute to the observed [CII] emission if it is clumped with a filling factor of about 10% or has a high ionization fraction (>10%).

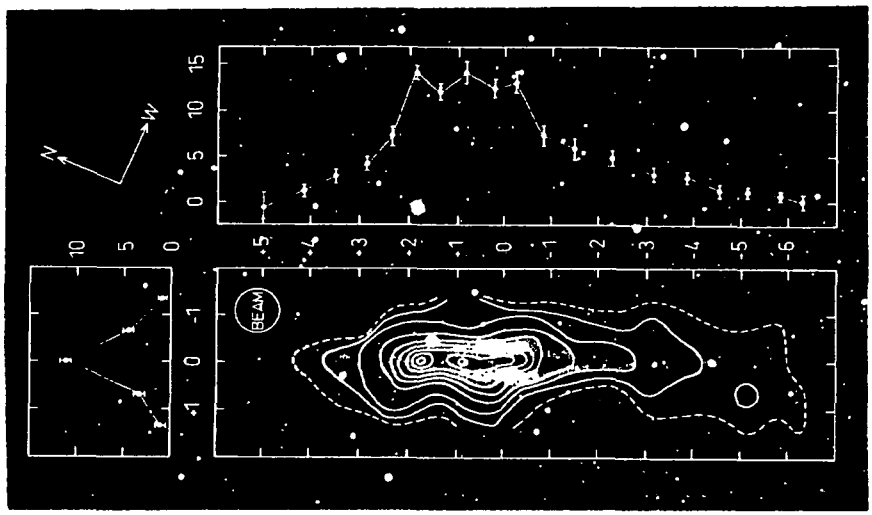

Figure 2. Integrated [CII] line intensity contours of NGC 891 shown on an optical image (lower right). The relative intensities of [CII] shown as a cuts along the plane of the galaxy (top) and along the z axis perpendicular to the plane (left) are shown. The peak [CII] line intensity is 1×10^{-4} erg $s^{-1}cm^{-2}sr^{-1}$ (Stacey *et al.* 1992).

References

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