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The ISM in the M82 Starburst

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ABSTRACT

We have observed [O I] (63 μm) and [Si II] (35 μm) in the central 44" (700 pc) of the starburst galaxy M82. The luminosities in these transitions are 7.1×10^7 $L_\odot$ and 6.2×10^7 $L_\odot$, respectively, which are each $\sim$ 0.15% of the bolometric luminosity from this region. The ratios of [O I] line luminosity to [O III], [Si II] (35 μm) and to bolometric luminosities in M82 are similar to those in M42, M17, and Sgr A. These similarities, and the association of the bulk of the [O I] and [Si II] emission with the ionized emission, suggest that the dominant emission mechanism for [O I] and [Si II] in M82 is the same as in these Galactic regions, namely warm gas photodissociated by UV flux from the OB stars responsible for the nearby H II regions. We argue that shock or X ray heated gas or H II plasma is a minor contributor to the intensities of these fine structure lines.

Both the [O I] (63 μm) and the [Si II] (35 μm) spectrum show an asymmetric line profile indistinguishable in shape from those of the [O III] (52 and 88 μm) and [N III] (57 μm) lines and similar to that of the more extended [C II] 158 μm line measured previously in M82. We detect two distinct velocity components, which we attribute to emission from two regions at either end of the central bar, where the bar connects to an orbiting torus of neutral gas seen in H I and CO J=1-0. We model separately the two velocity components and derive the physical conditions in these two regions by the method described in Wolfire *et al.* (1990).

The clouds in these regions are small, R$\sim$1–2 pc, have warm neutral gas surfaces, T$\sim$ 200 K, and are concentrated with volume filling factors of $\sim$ 0.02 and area filling factors of 1–5. The entire central region (R$\sim$ 700 pc) is characterized by a large number, $\sim 5\times10^4$, of $2\times10^3 M_\odot$ clouds with surface densities of $\sim 3\times10^4$ cm^{-3}, illuminated by FUV fluxes 10^4 times the average local interstellar value for the Milky Way. These clouds reside in the harsh conditions

of a starburst nucleus, with photoevaporation times of $\sim 10^6$ yr, and collision timescales only about an order of magnitude longer.

The gas phase Si abundance is high, nearly solar, and the enrichment is probably caused by supernovae-ejected elemental Si or by the destruction of silicate grains by fast supernovae-driven shocks.