The effect of radiation pressure on dust size distribution inside HII regions

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Abstract & Conclusions: Inside HII regions, past observations indicate that radiation pressure may affect distribution of dust size (Paladini et al. 2012). We therefore investigate the impact of radiation pressure on spatial dust distribution inside HII regions using one-dimensional radiation hydrodynamic simulations. In order to investigate the distribution of dust grains, we introduce two additional fluid components describing large and small dust grains. In a cloud of mass 10^5 $M_\odot$ and radius 17 pc, we find that radiation pressure accelerate large (0.1 μm) dust grains more efficiently than small (0.01 μm) grains, the large to small grain mass ratio becomes smaller by an order of magnitude relative to the initial one. Resulting dust size distributions depend on the luminosity of the radiation source. The large and small grain segregation becomes weaker when we assume stronger radiation source, since dust grain charges become larger under stronger radiation and hence coulomb drag force becomes stronger.

Methods: In our simulations, we place a radiation source at the centre of a spherically symmetric gas distribution. We solve the radiation transfer equation to include following processes: chemical reactions, heating-cooling processes of gas, and radiation pressure. The species we include in our simulations are H, He, electrons, and graphite (0.1, 0.01 μm). In order to determine the relative velocity between dust and gas, we include collisional drag force and coulomb drag force.

Results: We present densities, large-dust-to-gas mass ratio, small-dust-to-gas mass ratios, large-dust-to-small-dust mass ratios, and the dust charge as functions of radius in Fig 1. Note that the radiation source becomes stronger from Cloud 1 to Cloud 3. We find that radiation pressure preferentially removes large dust grains from HII regions in almost all simulations.

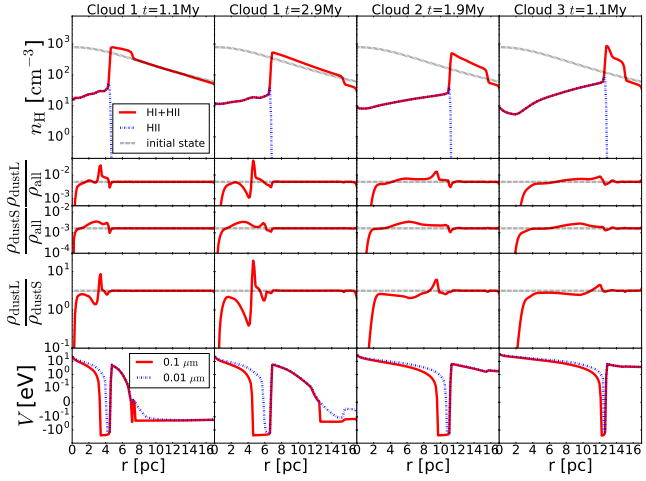

Figure 1: Density (top), large-dust-to-gas-mass ratio (second from the top), small-dust-to-gas-mass ratio (middle), large-dust-to-small-dust-mass ratio (second from the top),and dust charge (bottom) profiles. From left to right, we show the results for Clouds 1 at t = 1.3 Myr, Cloud 1 at t = 2.9 Myr, Cloud 2 at t = 2.2 Myr, and Cloud 3 at t = 1.3 Myr. The black dotted lines show the initial profiles. The red solid lines represent the results of simulations. The blue dashed lines at the top panels show the ionized hydrogen density profiles. In the bottom panels, the red solid lines and blue dashed lines show the charge of the large dust and the small dust respectively.