Triggered Star Formation in a Turbulent ISM
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ASTE CO(3-2) observations of M 83: Correlation between CO(3-2)/CO(1-0) ratios and star formation efficiencies

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Abstract. We have performed CO($J = 3 - 2$) emission observations with the Atacama Submillimeter Telescope Experiment (ASTE) toward the $5' \times 5'$ (or 6.6×6.6 kpc at the distance $D = 4.5$ Mpc) region of the nearby barred spiral galaxy M 83. We successfully resolved the major structures, i.e., the nuclear starburst region, bar, and inner spiral arms in CO($J = 3-2$) emission at a resolution of $22''$ (or 480 pc), showing a good spatial coincidence between CO($J = 3 - 2$) and 6 cm continuum emissions.

From a comparison of CO($J = 3 - 2$) data with CO($J = 1 - 0$) intensities measured with Nobeyama 45-m telescope, we found that the radial profile of CO($J = 3 - 2$)/CO($J = 1 - 0$) integrated intensity ratio $R_{3-2/1-0}$ is almost unity in the central region ($r < 0.25$ kpc), whereas it drops to a constant value, 0.6–0.7, in the disk region. The radial profile of star formation efficiencies (SFEs), determined from 6 cm radio continuum and CO($J = 1 - 0$) emission, shows the same trend as that of $R_{3-2/1-0}$. At the bar-end ($r \sim 2.4$ kpc), the amounts of molecular gas and the massive stars are enhanced when compared with other disk regions, whereas there is no excess of $R_{3-2/1-0}$ and SFE in that region. This means that a simple summation of the star forming regions at the bar-end and the disk cannot reproduce the nuclear starburst of M 83, implying that the spatial variation of the dense gas fraction traced by $R_{3-2/1-0}$ governs the spatial variation of SFE in M 83.

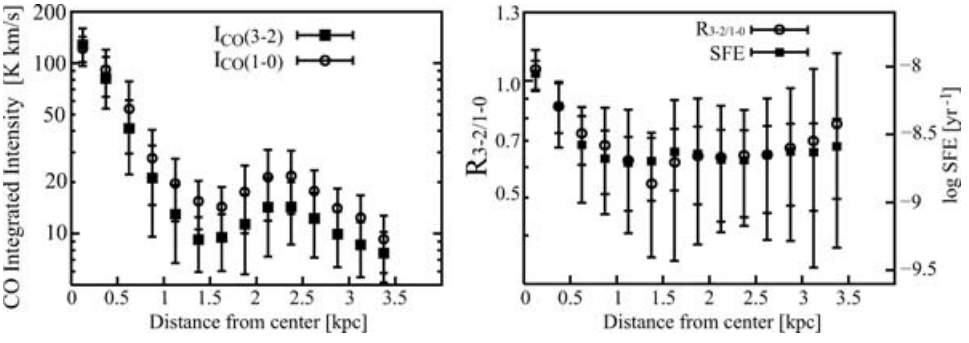

Figure 1. (left) CO($J = 3 - 2$) and CO($J = 1 - 0$) line intensities, tracing the amounts of molecular gas, as a function of the galactocentric radius of M 83. Both intensities are enhanced at the bar-end ($r \sim 2.4$ kpc). (right) The azimuthally averaged SFE and $R_{3-2/1-0}$ as a function of the galactocentric radius of M 83. No significant enhancement is visible at the bar-end, despite the fact that there is a secondary peak in the CO intensities.