

ALMA2019: Science Results and Cross-Facility Synergies



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HCN laser lines in carbon-rich evolved stars

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Abstract:

HCN is one of the most abundant molecules in the circumstellar envelopes of carbon-rich AGB stars. Recent APEX surveys have revealed widespread presence of HCN maser emission in the innermost regions of these envelopes at millimetre wavelengths. Besides millimetre-range masers, HCN is also known to exhibit two intense lasers in the submillimetre frequencies near 805 and 891 GHz, whose frequencies are in the highest frequency band of ALMA. Previous single-dish observations with the CSO and Herschel have detected these laser lines at extraordinarily high flux densities of a few thousand Jansky in carbon-rich stars. In Cycle 6, we have carried out a pilot imaging survey of HCN lasers for several carbon-rich evolved stars in ALMA Band 10 with the intermediate (~ 1 km) baselines. Among the targets that have been observed, we have invariably detected intense emission of the two HCN laser lines in the innermost circumstellar envelopes. Due to the lack of nearby, bright quasars at high ALMA frequencies, calibration of the rapidly varying interferometric phases is very challenging. The bright and compact nature of the laser-emitting regions in carbon-rich evolved stars makes it possible to self-calibrate the data and improve the dynamic ranges of the images. We will present the first results from Cycle 6, which demonstrate that self-calibration with HCN lasers can drastically improve the dynamic range by two orders of magnitude to about ~ 2000 in Band 10. This can yield high-fidelity detailed images of the stars' radio photospheres with high-frequency, long-baseline observations in the future.

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