

ALMA Observation of Mass Loss from Massive Stars

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Abstract. We present a pilot study of using the Atacama Large Millimeter/sub-millimeter Array (ALMA) continuum observations to constrain the density structure in the intermediate wind zone of massive stars, in which the wind is extremely sensitive to clumping.

Keywords. Stars, stars: mass loss, stars: early-type, radio continuum: stars, submillimeter

1. Using ALMA to determine mass loss rates from massive stars

The fast, dense outflows from massive OB type stars are driven by radiative line acceleration. Multiple evidence points to an over-estimation of the currently accepted mass-loss rates from these stars as shown by inconsistencies in results derived using different diagnostics, attributed to wind clumping. Potential downward revisions of mass-loss rates of massive stars have a profound effect on the stars' evolution, the feedback from them, and in turn affects the evolution of the host galaxy. We urgently need to establish the true mass-loss rates of OB stars, by constraining the clumping structure. Models predict that the clumping is radially stratified. If the radial stratification of clumping is known from consistent analyses of different diagnostic methods, realistic mass-loss rates can be derived. (Sub-)mm observations of stellar winds will provide the critical diagnostics for the clumping structure in the currently unconstrained intermediate wind regions of massive OB stars, in which the wind is extremely sensitive to clumping. Our pilot study showed that ALMA can efficiently provide the necessary (sub-)millimeter data.

(Sub-)millimeter fluxes of selected bright OB type stars with available multi-wavelength observation result, HD 37043, HD 37128, HD 37742, HD 38771, HD 66811, HD 149757, HD 151804, and HD 152236, were obtained by ALMA between April 2013 – April 2014, using continuum observing mode in the ALMA bands B3, B6 and B7 (respectively at 100, 230, 345 GHz). The data was reduced and calibrated using the standard ALMA reduction scripts using CASA. Subsequently obtained CLEANed maps have S/N > 8. The (sub-)millimeter SEDs show mostly spectral indices consistent with emission from thermal winds. One target may show a non-thermal emission. Our next step is to combine analysis of all diagnostics from the Far-UV to the radio domain with consistency, to derive the clumping properties throughout the entire wind and help to constrain the physical origin of wind clumping. Expanding the sample and using more ALMA band coverage is necessary to get the complete true mass-loss rate of massive stars.

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