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The fast, massive outflow of the pre-planetary nebula IRAS 19374+2356

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Abstract

At some point in the late-AGB stage, a process (or processes) becomes operative that accelerates and imposes bipolarity upon the slow, spherical AGB winds. What produces bipolarity in these objects and at what stage does bipolarity manifest itself are key questions that remain yet poorly understood.

We present CO (115 & 230 GHz) emission maps of IRAS19374+2359, an extreme pre-PN with an unparalleledly massive, fast molecular outflow discovered in our OVRO Post-AGB CO 1–0 emission Survey (referred to as OPACOS; Sánchez Contreras & Sahai 2012, ApJS, 203, 16). We present sub-arcsecond resolution $^{(12,13)}$CO 2–1 and 1.3 mm-continuum interferometric maps recently obtained with the Submillimeter Array (SMA) together with our discovery $\sim$8″-resolution $^{(12,13)}$CO $1-0$ OVRO data. The prominent $\sim$ 300 km s^{-1}-broad wings and the lack of an intense, low-velocity CO line core in IRAS 19374 indicate that most or all of the molecular gas participates in the high-velocity flow. From our CO data, we estimate a total mass in the molecular outflow of ~ 1 M$_\odot$ and an unprecedentedly large value for the linear momemtum carried of ≥ 45 M$_\odot$ km s^{-1}. Our SMA maps show CO emission arising from a $\sim 3''\times 2''$ hourglass-shaped molecular flow aligned with the optical lobes; a linear velocity gradient along the lobes as well as equatorial expansion at the nebula waist are found. The spatio-kinematic structure of this object is in support of a jet-envelope entrainment scenario in which a substantial amount of directed momentum is transferred to large parts of the dense AGB wind by interaction with fast, collimated post-AGB jets.