N87-15046

HIGH RESOLUTION OBSERVATIONS OF THE L1551 BIPOLAR OUTFLOW

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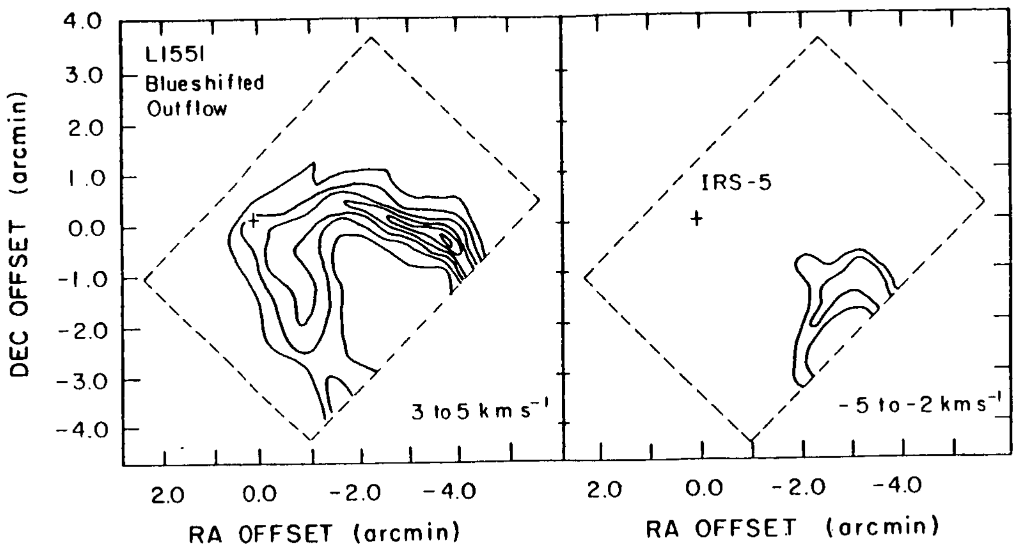
ABSTRACT

The nearby dark cloud Lynds 1551 contains one of the closest examples of a well-collimated bipolar molecular outflow. This source has the largest angular size of any known outflow and was the first bipolar outflow to be detected (Snell, Loren, and Plambeck 1980). The outflow originates from a low-luminosity young stellar object, IRS-5, discovered by Strom, Strom, and Vrba (1976). Optical and radio continuum observations (Cohen, Bieging, and Schwartz 1982; Mundt and Fried (1983); Snell et al. 1985) show the presence of a highly collimated, ionized stellar wind orginating from close to IRS-5 and aligned with the molecular outflow. However, we have little information on the actual mechanism that generates the stellar wind and collimates it into opposed jets. The VLA observations indicate that the winds originate within 10^{15} cm of IRS-5, unfortunately at a size scale difficult to resolve. For these reasons, observations of the structure and dynamics of the hypersonic molecular gas may provide valuable information on the origin and evolution of these outflows. In addition, the study of the impact of the outflowing gas on the surrounding molecular material is essential to understand the consequences these outflows have on the evolution and star formation history of the entire cloud.

Though L1551 is the largest angular-sized outflow known, high angular resolution observations are still essential to fully resolve the complex dynamics that are present. The study by Snell and Schloerb (1985) provides some relevant insights into the structure of the molecular jets. This investigation utilized a lunar occulatation to obtain a high angular resolution (7 arcsec) CO observations of a cut though the blueshifted lobe of high velocity emission. Their single cut suggested that the lowest velocity outflowing gas was located at the periphery of the outflow, while the highest velocity gas was located at the center. Snell and Schloerb suggested that the data could be best modelled if the high velocity gas was confined to a expanding shell surrounding a cavity mostly evacuated of molecular material which may presently be filled with a low density stellar wind. The boundary of the shell was found to be coincident with the faint reflection nebulosity visible on the POSS photographs and interpreted by Snell et al. (1985) as scattered light from the stellar wind/molecular cloud interface.

The severe limitation in coverage of the outflow in the Snell and Schloerb observations begged for a more complete map at high angular resolution. Moriarty-Schieven et al. (1986) obtained a oversampled map of the CO emission of a portion of both the blueshifted and redshifted outflows in L1551 using Five College Radio Astronomy Observatory 14 m telescope. Data were obtained every 12 arcsec with a HPBW of 45 arcsec. The oversampled maps have been reconstructed to an effective angular resolution of 20 arcsec using a maximum entropy algorithm (Grasdalen, Hackwell, and Gehrz 1983). A portion of the blueshifted lobe of high velocity emission in L1551 is shown in the enclosed Figure for two

velocity intervals; on the right the highest velocity blueshifted emission (-5 to -2 km s^{-1}) and on the left the lowest velocity blueshifted emission (3 to 5 km s^{-1}). The bulk of the high velocity emission is found in the 3 to 5 km s^{-1}



interval and delineates a shell-structure at the periphery of the outflow. The highest velocity gas is located at the center and is thought to represent gas on the front face of the shell expanding toward the observer. Similar kinematics and structure is also found for the redshifted outflow. The shell structure is found to be coincident with the arc of reflection nebulosity that presumably delineates the extent of the cavity and provides confirmation that such a shell model for the molecular outflow must be correct.

A continuation of the study of Moriarty-Schieven et al. will be presented at this meeting. The entire L1551 outflow has now been mapped at 12 arcsec sampling requiring roughly 4000 spectra. This data has been reconstructed to 20 arcsec resolution to provide the first high resolution picture of the entire L1551 outflow. This new data has shown that the blueshifted lobe is more extended than previously thought and has expanded downstream sufficiently to break out of the dense molecular cloud, but the redshifted outflow is still confined within the molecular cloud. Details of the structure and kinematics of the high velocity gas will be used to test the various models of the origin and evolution of outflows.

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