Astronomy with Millimeter and Submillimeter Wave Interferometry
ASP Conference Series, Vol. 59, 1994
M. Ishiguro and Wm. J. Welch (eds.)

PROBING THE AU-SCALE STRUCTURE OF MOLECULAR CLOUDS

ALAN P. MARSCHER AND THOMAS M. BANIA
Department of Astronomy, Boston University, 725 Commonwealth Ave., Boston, MA 02215

ZHONG WANG
IPAC, 100-22, California Institute of Technology, Pasadena, CA 91125

ABSTRACT

Monitoring absorption lines in the radio spectra of compact extragalactic sources that lie behind local molecular clouds provides a method for exploring the AU-scale structure of the foreground clouds.

INTRODUCTION

Several bright, compact, extragalactic radio sources happen to lie behind molecular clouds in our Galaxy. In the Earth's reference frame the foreground cloud moves in the plane of the sky as a function of time owing to proper motion, parallax, and the Solar Motion, while the background source remains essentially stationary (see Fig. 1). The background source can therefore be used as a milliarcsecond-scale beam capable of probing the AU-scale structure of the foreground cloud through observations of time variability in absorption-line profiles.

A METHOD FOR EXPLORING THE MILLIARCSECOND-SCALE STRUCTURE OF MOLECULAR CLOUDS

We have begun a program to use the Owens Valley Millimeter Array to monitor the CO absorption and the VLA to monitor the formaldehyde (H_2CO) absorption toward BL Lac, NRAO 140, NRAO 150, and 3C 111, all of which lie behind local molecular clouds. VLBI spectral line observations will be even more powerful, since the probing "beam" will be resolved into the core and compact jet. The background source will therefore serve as a multi-beam array tracing a corkscrew pattern across the cloud.

Structure in H I absorption has been reported on a scale of 25 AU by Diamond et al. (1989). Marscher (1988) has also reported an X-ray absorption event toward the quasar NRAO 140 that requires a clump of AU size scale and density exceeding 10^9 cm^{-2} to have passed in front of the quasar in 1980. Theoretically, molecular gas is expected to clump on AU size scales during the star formation process, but such gravitational condensations should be rare for any single chosen line of sight. Turbulence also causes clumping, in which case the size of the smallest clumps would correspond to the inner scale of the turbulence,

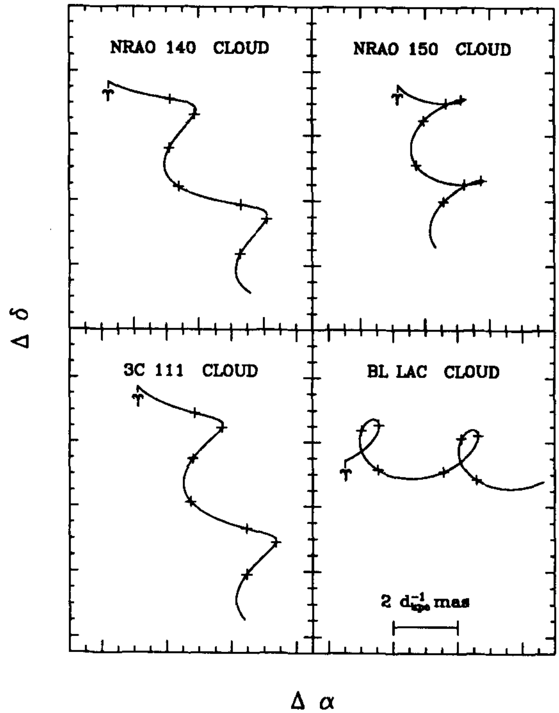

FIGURE I Apparent path traced by the background compact continuum source relative to the foreground molecular cloud for each source in our observing list. Each path corresponds to the apparent secular motion over a two-year period starting with the vernal equinox (marked as "♈"). Each 3-month period is marked by a cross.

which is unknown for molecular clouds. Detection of AU-scale structure through these absorption-line observations would therefore be highly significant for our understanding of physical processes in molecular clouds.

ACKNOWLEDGMENTS

APM and TMB gratefully acknowledge partial support for this project by the US National Science Foundation, under grant AST-9116525.

REFERENCES

Diamond, P., Goss, W. M., Romney, J. D., Booth, R. S., Kalberla, P. M. W., Mebold, U. 1989, ApJ, **347**, 302

Marscher, A. P. 1988, ApJ, **334**, 552