

INFRARED EXTINCTION AND THE INITIAL CONDITIONS FOR STAR AND
PLANET FORMATION

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Annual Report

For the Period 1 May 2001 through 30 April 2002

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Infrared Extinction and the Initial Conditions for Star and Planet Formation

This grant funds a research program to use infrared extinction measurements to probe the detailed structure of dark molecular clouds and investigate the physical conditions which give rise to star and planet formation. The goals of the this program are to: 1) acquire deep infrared and molecular-line observations of a carefully selected sample of nearby dark clouds, 2) reduce and analyze the data obtained in order to produce detailed extinction maps of the clouds, 3) prepare results, where appropriate, for publication. These goals were met as follows:

1) We conducted three major and successful observing runs during the period under consideration: First, we obtained sensitive infrared imaging observations of a modest but significant sample of dark clouds with the New Technology Telescope (NTT) of the European Southern Observatory (ESO) in La Silla Chile. Second, we obtained deep near-infrared observations of IC 5146, our prime northern hemisphere target using the new FLAMINGOS wide field imager on both the NOAO 4-m telescope on Kitt Peak Arizona and the 6-m MMT on Mt Hopkins Arizona. With these data sets we have completed the core infrared data acquisition for our Origins program. Third, we used the IRAM 30-meter millimeter-wave telescope in Spain to obtain additional critical and sensitive observations of the B 68 cloud, which is one of our prime targets in the southern hemisphere and which we had already imaged in the infrared with the NTT in an earlier observing season.

2) During this period we reduced all our NNT observations of our Bok Globule sample and our extensive survey of the Lupus clouds. We have also reduced our new and expanded 1.2 meter telescope infrared survey of the IC 5146 cloud and the L 781 cloud. We have constructed catalogs of our reduced infrared observations and have begun analysis of the Lupus survey and the L 781 cloud. Preliminary results for the Lupus survey were presented at the annual winter meeting of the American Astronomical Society in January 2001. We have also begun the reduction and analysis of the millimeter-wave line observations from our three earlier IRAM observing runs. This analysis has led to the discovery of a new dynamical state of certain molecular clouds which appear to be experiencing small amplitude non-radial oscillations around a state of stable equilibrium, similar to those experienced by stars. In addition we have also discovered compelling evidence for molecular gas-phase depletion in the B 68 cloud, including the first important detection of the depletion of the nitrogen bearing species N_2H^+ . We have analyzed and published, extinction observations of the globule B335 obtained with the Hubble Space Telescope. These observations have enabled us to prescribe the detailed structure of this cloud and are the first to demonstrate the effect of molecular outflow on the radial distribution of density in a protostellar cloud. Finally, we have reduced and analyzed submillimeter continuum observations of IC 5146 and have combined these data with our deep extinction survey of IC 5146 to map the temperature structure in the cloud and its individual cores. These observations have enabled us to simultaneously map the dust emissivity in the cores and have resulted in direct evidence for grain growth in the cold pre-stellar cores within the cloud. The results are being prepared for publication.