Final Technical Report
NASA (FUSE) Grant: NAG5-10324
Title: The Physical Character of Small-Scale Interstellar Structures
Program ID: B046 (Cycle 2)
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The primary objective of this program was to obtain FUSE observations of the multiple interstellar absorption lines of H$_2$ toward the members of 3 resolvable binary/multiple star systems to explore the physical conditions in known interstellar small-scale structures. Each of the selected systems was meant to address a different aspect of the models for the origin of these structures:

1) the stars HD 32039/40 were meant to probe a temporally varying component which probed a cloud with an inferred size of tens to a few hundreds of AU. The goal was to see if there was any significant H$_2$ associated with this component.

2) the star HD 36408B and its companion HD 36408A (observed as part of FUSE GTO program P119) show significant spatial and temporal (proper motion induced) Na I column variations in a strong, relatively isolated component, as well as a relatively simple component structure. The key goal here was to identify any differences in H$_2$ or C I excitation between the sightlines, and to measure the physical conditions (primarily density and temperature) in the temporally varying component.

3) The stars HD 206267C and HD 206267D are highly reddened sightlines which showed significant variations in K I and molecular absorption lines in multiple velocity components. Coupled with FUSE GTO observations of HD 206267A (program P116), the goal was to study the variations in H$_2$ along sightlines which are significantly more distant, with larger separations, and with greater extinctions than the other selected binary systems.

Observations for this program were carried out between January 6th, 2001 and June 30th, 2002. Unfortunately due to FUSE reaction wheel problems we were unable to obtain the planned observations of HD 36408B, and instead substituted additional observations of HD 206267A. The results of these observations was somewhat mixed, with no significant H$_2$ being detected toward HD 32039/40 (at odds with some theoretical suggestions). These results are being combined with our recently obtained HST observations of the HD 32040 sightline for publication purposes. The submission for publication of the combined HST and FUSE analysis is expected sometime in 2005.

Unlike HD 32039/40, copious H$_2$ was detected toward all three stars in the HD 206267 system, and the analysis of this data formed the basis for the senior honors thesis of Matthew Turk at Northwestern University (June 2003). These results suggested that while there was little difference in the total H$_2$ column toward these stars, there were some differences in the
H$_2$ excitation along these sightlines. A preliminary draft of an *Astrophysical Journal* article discussing these results (as well as the results of our supporting ground–based observations) was begun, but failed to be completed due to the demands of graduate school on Matt’s time. After much discussion the responsibility for the preparation of the final manuscript was moved back to Northwestern University in the Fall of 2004, and is currently on–going.