W49A North -- Global, Local, or No Collapse?

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OVERVIEW

Radiative transfer calculations have been performed in order to fit profiles of several CS transitions observed towards HII regions A, B, and C in the star-forming complex W49A North.

W49A NORTH

The FIGURE AT LEFT shows the locations of some of the ultracompact HII regions (letters) in Welch et al. ‘s “ring of HII regions” superposed on the integrated emission from the CS J=2-1 transition observed with a 5' beam with the Berkeley-Illinois-Maryland Array (Dickel et al. 1999). Additional CS-emission and HII regions are present to the northeast of the region shown here. The CS spots into absorption against the continuum emission from the prominent HII region G.

THREE SCENARIOS

Three scenarios were considered:

1. Global collapse of a large (5 pc radius) cloud (Welch et al. 1987).
2. Local collapse of smaller (1 pc radius) clouds (Keto et al. 1991).
3. Multiple static clouds (Serabyn et al. 1993).

Parameters were varied in order to obtain a reasonable fit to the observations.

SKETCH -- MODELS AND TABLES of parameters

Clouds A and C in the final collapse scenarios include an inner uniform, static core delineated by the inner dashed (or dotted) circles in the SKETCH and an outer collapsing envelope. The parameters of these dominant clouds are given in the TABLES for the 3 final models.

PROCEDURE

The multi-level, non-LTE radiative transfer code “H” (Dickel & Auer 1994) is used to derive the emergent intensities and optical depths as functions of impact parameter, velocity, and transition for a component cloud. For each cloud in the model, its velocity and relative position in the sky and along the line-of-sight are specified and the program “mc” uses the “h” output to calculate the radiative transfer along the desired lines of sight and displays the results as illustrated below.

TWO–CLUMP MODEL AND OBSERVED CS PROFILES

The BOTTOM LEFT FIGURE shows the CS spectra from the best-fit two-clump model (for Serabyn et al.’s “SM” and “Center” clumps) as smooth curves with the observed data overlaid as histograms.

RESULTS

PROFILES FOR THE FINAL MODELS

The BOTTOM RIGHT FIGURE shows CS profiles for the final local collapse model. Clouds A and C, and account for most of the CS emission seen towards HII region B. Similar improvements are obtained for the other two models.

MAIN CONCLUSIONS

• For all three scenarios, it is possible to find combinations of parameters that reproduce the CS profiles reasonably well provided that the component clouds have a core/envelope structure.
• Cores with high temperature and high molecular hydrogen density are needed to match the intensities of the higher transitions, such as J=7-6 with a 20" beam.
• The low density gas needed to create the inverse P-Cygni profile (absorption) seen in the CS J=2-1 line with the 5' beam towards the HII region G arises from different components in the 3 models. The infalling envelope of C plus a contribution from cloud B creates the absorption in global collapse, cloud B is responsible in local collapse, and a separate cloud G’ is needed in the case of many static clouds.

More recent observations of H recombination lines (De Pree et al. 1997) and of the continuum emission (De Pree et al. 2000) suggest that the UCHII regions are associated with and embedded within individual clumps that fragmented out of a collapsing cloud, but we must await high resolution observations of CS J=1-0 and of the higher transitions of optically thin CS* combined with full 3-D modeling to confirm this emerging picture.

REFERENCES

Dickel et al. 1999, ApJS 125, 413
Welch et al. 1987, Science, 238, 1550