

# Self-consistent Theoretical Models of Collapsing Pre-stellar Cores

V. Shematovich<sup>1</sup>, B. Shustov<sup>1</sup>, D. Wiebe<sup>1</sup>, Ya. Pavlyuchenkov<sup>1</sup>,  
and Z.-Y. Li<sup>2</sup>

<sup>1</sup>Institute of Astronomy, Russian Academy of Sciences, Moscow, 119017 Russia  
email: shematov@inasan.rssi.ru

<sup>2</sup>University of Virginia, Charlottesville, VA 22903, USA

**Abstract.** We present a coupled dynamical and chemical model for collapsing pre-stellar cores (Li *et al.* (2002); Shematovich *et al.* (2003); Pavlyuchenkov *et al.* (2003)). It treats the dynamics of thermally and magnetically supported cores in 1D, with an extended chemical network incorporated. The latest version of the model includes UV-irradiation of the core envelope, and gas and dust energetics. We have also developed a 2D Monte Carlo model of radiative transfer to compute molecular line profiles for comparison with observations.

The model allowed us to constrain evolutionary scenarios for collapsing pre-stellar cores, to calculate molecular line profiles from the spatial distribution of chemical species and the velocity field, and to characterize the chemical properties of dense cores.

We have determined line profiles along multiple lines of sight through a given pre-stellar core. This allowed us to compare model predictions with the observational maps of molecular lines available for L1544 and other well studied cores. The comparison of synthetic and observed line profile maps contributed to the understanding of the velocity field and pattern of chemical differentiation observed in individual cores.

Possible ways to extend the model to the protostellar phase are also discussed.

**Keywords.** ISM: astrochemistry, ISM: pre-stellar cores, stars: formation

---

## References

- Li, Z.-Y., Shematovich, V. I., Wiebe, D.S., Shustov, B. M., 2002, *ApJ* 569, 792  
Pavlyuchenkov, Ya. N., Shustov, B. M., Shematovich, V. I., Wiebe, D.S., Li, Z.-Y. 2003, *Astronomy Reports* 47, 176  
Shematovich, V. I., Wiebe, D.S., Shustov, B. M., Li, Z.-Y. 2003, *ApJ* 588, 894