

A Molecular Line Survey of CRL 2688 at 1 mm and 3 mm Wavelengths

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Abstract. It is well established that circumstellar envelopes (CSEs) around evolved stars are active sites of molecular synthesis, and CSEs are one of the major sources of chemical enrichment in the interstellar space. The investigation of molecular compositions in CSEs is essential to understand the chemical evolution of the Galaxy. In order to study circumstellar chemistry in different environments, we have been systematically performing molecular line surveys of a sample of evolved stars from asymptotic giant branch (AGB) stars, proto-planetary nebulae (PPNs), to planetary nebulae (PNs). The dynamical time scales in different evolutionary stages can impose a time limit on the reaction time scales. Here we report our results for CRL 2688.

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The significance of molecular line surveys of CSEs has been recently addressed by Cernicharo *et al.* (2011). CRL 2688 (egg nebula) is a bright bipolar PPN, and serves as an ideal target to study the details of transition from AGB to PN phases which are poorly understood because of the short evolutionary time scale. The observations were performed using the ARO 12m and SMT 10m radio telescopes during the period from 2005 April to 2006 September. The frequency ranges are from 71–111 GHz, 157–160 GHz, and 218–267 GHz. The integration time for each frequency setting is 1–2 hours, achieving a typical sensitivity of $T_R < 10$ mK. Using the same observation settings, we also observed other C-rich CSEs including IRC+10216, CIT 6, CRL 3068, and NGC 7027 (He *et al.* 2008; Zhang, *et al.* 2008, 2009a,b), which cover an evolutionary sequence from AGB to PN stages. The detected molecules include CO, CN, CS, SiO, SiS, C₂H, HCN, HNC, SiC₂, C₃H, C₃N, C₄H, C₅H, HCO⁺, H₂CO, H₂CS, HC₃N, HC₅N, CH₃CN, and their isotopomers. This is the deepest molecular line survey of this object to date.

Comparing the spectrum of CRL 2688 with those of IRC+10216 and NGC 7027, we found that long carbon-chain molecules are being quickly formed and Si-bearing molecules are depleted into dust grains in the transition from AGB to PPN. During the evolution from PPN to PN, neutral molecules are destroyed, and ionic molecules are produced. Therefore, molecules in CSEs are rapidly processed due to dramatically changing physical conditions. Quantitative results will be reported in a refereed paper.

References

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