Triggered Star Formation in a Turbulent ISM
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Chemical structure of the massive protobinary-forming hot core, W3(H_2O)

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Abstract. The hot molecular core, W3(H_2O), contains a massive protobinary system that is cocooned by dense gas (n(H_2) $\sim 10^7$ cm^{-3}), with about 1 arcsec ($\sim$ 2000 AU) separation of the binary system. We investigate chemical properties of the gas components around this binary system using the mm-wave transitions of complex molecules, CH_3CN, SiO, HNCO, and CH_3CH_2CN, observed with the BIMA array. The two protostellar objects, A and C in W3(H_2O), can be distinguished using chemical properties, suggesting that the source A may be younger than the source C within the time scale of less than 10^4 years. The hot core around the source C, traced by CH_3CH_2CN and the K=6 component of CH_3CN, seems to have more time for chemical evolution than the source A. The SiO emission in this region suggests that there was an influence from the outside of the W3(H_2O) and W3(OH) hot cores. The nitrogen chemistry may be more active in the later stage than the oxygen chemistry, but the chemical evolution of the protostellar envelopes may not be monotonic as previously suggested.

Keywords. ISM: abundances, ISM: clouds, ISM: molecules, ISM: individual (W3(H2O)), astrochemistry, molecular processes

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A massive-star forming hot core, W3(H_2O), locates at the 6$''$ east of the UC HII region W3(OH). These objects are embedded in the giant molecular complex W3 at a distance of about 2 kpc. W3(H_2O) contains a protostellar (B0.5-0) binary system (the A and C component in continuum) in orbit with each other with a velocity difference $\Delta V_{A-C} = 2.81$ km s^{-1} (Chen *et al.* 2006, ApJ, 639, 975; and see references therein). The small angular size (a few arcsecond in diameter) of this hot core requires sub-arcsecond angular resolution to properly resolve the two protostellar objects embedded in the dense gas and dust cocoon of n(H_2) $\sim 10^7$ cm^{-3}.

The chemical evolutionary time scale is relatively short, which helps to understand the nature of very complicated high mass star forming cores. We model the structure of this protostellar system using the chemical tracers, CH_3CN, SiO, HNCO, and CH_3CH_2CN observed with the BIMA array. Chemical differences exist between A and C, probably because of the difference in their chemical evolutionary stages.

In the chemical evolution of hot cores there are, at least, two different formation periods of N-containing species, such as CH_3CN, for the warm extended component and the highly turbulent compact component. The fact that CH_3CH_2CN exists mainly in source C suggests that source C is more chemically evolved than source A. HNCO may trace an expanding shell around the highly turbulent gas of A and C, where YSOs are embedded. The SiO emission seems to trace the shocked gas existing outside of these hot cores.