Radio Continuum and Recombination Line Study of 16 UC HII Regions with Extended Envelopes

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In order to search for extended emission associated with ultracompact (UC) HII regions, we have carried out radio continuum observations of 16 UC HII regions at 21 cm using the Very Large Array (VLA). The UC HII regions are the ones that have simple morphologies and large ($\gtrsim$10) ratios of single-dish to VLA fluxes. We detected extended emission from all the sources. The extended emission consists of one to several compact components and diffuse extended envelope in each source. All the UC HII regions but two are located in the compact components and correspond to their peaks. The compact components with UC HII regions are usually smaller than the ones without UC HII regions. Our H76α and He76α line observations show that the ultracompact, compact, extended components in each source have approximately the same central velocity, suggesting that the three components are not chance coincident but physically associated. According to the surface brightness distribution and comparison between the Lyman continuum photon fluxes of the three kind of components, the UC HII regions and their associated compact components are likely to be excited by the same source while the compact components in the individual objects appear to be ionized by separate sources. We present a simple model in which our results can be understood using the Champagne flow model and hierarchical structure of molecular clouds. Our model may suggest that the co-existence of ultracompact, compact, and extended components are not unusual in the evolution of HII regions within hierarchically clumped molecular clouds and that the ultracompact cores of HII regions could survive over $\sim 10^5$yr. We found that about 70% of known UC HII regions with simple morphology have the flux ratios in excess of 5. If they all were not real UC HII regions as our sources, the age problem would be significantly alleviated.