

Way-like galaxies by modeling the probability of successful travel of organic compounds between stars harboring potentially habitable planets. To this end, we apply the modified habitability recipe of Gobat & Hong (2016) to a model galaxy from the MUGS suite of zoom-in cosmological simulations. We find that, unlike habitability, which only occupies narrow dynamic range over the entire galaxy, the panspermia probability can vary be orders of magnitude between the inner ( $R, b = 1\sim 4$  kpc) and outer disk. However, only a small fraction of star particles have very large values of panspermia probability and, consequently, the fraction of star particles where the panspermia process is more effective than prebiotic evolution is much lower than from naïve expectations based on the ratio between panspermia probability and natural habitability.

The lunar surface progressively darkens and reddens as a result of sputtering from solar wind particles and bombardment of micrometeoroids. The extent of exposure to these space weathering agents is frequently calculated as the location in a diagram of reflectance at 750 nm

## 항성 및 항성계

### [구 SA-01] Long-term simultaneous monitoring observations of SiO and H<sub>2</sub>O masers toward Mira variable WX Serpentis

Jang Ho Lim<sup>1</sup>, Jaeheon Kim<sup>2</sup>, Seong Min Son<sup>1</sup>, Kyung-Won Suh<sup>1</sup>, Se-Hyung Cho<sup>2,3</sup>, Haneul Yang<sup>2,3</sup>, and Dong-Hwan Yoon<sup>2</sup>

<sup>1</sup>Chungbuk National University

<sup>2</sup>Korea Astronomy and Space Science Institute

<sup>3</sup>Seoul National University

We carried out simultaneous monitoring observations of five maser lines, H<sub>2</sub>O (22 GHz), SiO  $v=1, 2, J=1-0$  (43.1, 42.8 GHz), and SiO  $v=1, J=2-1, J=3-2$  (86.2, 129.3 GHz), toward the Mira variable star WX Serpentis with the 21-m antennas of the Korean VLBI Network (KVN) in 2009-2021 (~12 years). Most spectra of the H<sub>2</sub>O maser are well separated into two parts of two blue- and one redshifted features within  $\pm 10$  km s<sup>-1</sup> of the stellar velocity. All detected SiO masers are generally concentrated within  $\pm 5$  km s<sup>-1</sup> of the stellar velocity, and sometimes appear split into two components. Overall, the profiles of SiO and H<sub>2</sub>O masers detected in WX Serpentis illustrate typical characteristics of the Mira variable. In addition, flux variations of both SiO and H<sub>2</sub>O masers are well correlated with the optical light

curve of the central star, showing a phase lag of  $\sim 0.1$  for SiO masers and  $\sim 0.2$  for H<sub>2</sub>O maser. This phenomenon is considered to be the direct effect of propagating shock waves generated by the stellar pulsation, because SiO and H<sub>2</sub>O masers are sequentially distributed at different positions with respect to the central star. In addition, we analyzed long-term trends and characteristics of maser velocities, maser ratio, and the velocity extents (the full width at zero power; FWZP). We also investigated a spectral energy distribution (SED) ranging from 1.2 to 240  $\mu$ m obtained using several infrared data: 2MASS, WISE, IRAS, ISO, COBE DIBRE, RAFL, and AKARI (IRC and FIS). From the IRAS LRS and ISO SWS spectra of this star, we identified 9.7 and 12  $\mu$ m silicate emission features consistent with the SE6 spectrum model, corresponding to the typical AGB phase.

### [구 SA-02] Twelve-year simultaneous monitoring of the SiO and H<sub>2</sub>O masers toward AGB stars: RT Vir, RR Aql, IRC-10151

Seong Min Son<sup>1</sup>, Jaeheon Kim<sup>2</sup>, Jang Ho Lim<sup>1</sup>, Kyung-Won Suh<sup>1</sup>, Se-Hyung Cho<sup>2,3</sup>, Dong-Hwan Yoon<sup>2</sup>, and Haneul Yang<sup>2,3</sup>

<sup>1</sup>Department of Astronomy and Space Sciences, Chungbuk National University

<sup>2</sup>Radio Astronomy Division, Korea Astronomy and Space Science Institute

<sup>3</sup>Astronomy Program, Department of Physics and Astronomy, Seoul National University

We present the results of long-term simultaneous monitoring observations (~12 years) of H<sub>2</sub>O (22 GHz) maser and several vibrationally excited lines of SiO  $J=1-0, 2-1, 3-2$  masers (43, 86, 129 GHz) carried out with the 21-m antennas of the Korean VLBI Network (KVN) toward a sample of three AGB stars (RT Vir, RR Aql, IRC-10151) that are believed to be semiregular variable star, Mira variable star, and OH/IR star, respectively, according to a sequential evolutionary phase of AGB star. A total 10 transitions were observed, of which we detected H<sub>2</sub>O, SiO  $v=1$  and  $2, J=1-0$ , SiO  $v=1, J=2-1$  and  $J=3-2$  maser lines in all three target objects, depending on the observational epochs. In this study, we scrutinize the evolutionary traits of each target object based on the maser line profiles, flux/velocity variations, and phase lags with the optical light curves. The IRAS two color diagram and the infrared spectral energy distributions (SEDs) in the wavelength range from 1.2 to 240  $\mu$ m of three observed sources were also analyzed.

### [구 SA-03] M to mid-L type members of