N03a Strong magnetic field generated by the extreme red supergiant VY Canis Majoris

Hiroko Shinnaga (Kagoshima University), Mark J. Claussen (NRAO), Satoshi Yamamoto (University of Tokyo), Masumi Shimojo (NAOJ)

Evolved stars experience high mass-loss rates forming thick circumstellar envelopes (CSEs). The circumstellar material is made of the result of stellar nucleosynthesis and, as such, plays a crucial role in the chemical evolution of galaxies and the universe. Since asymmetric geometries of CSEs are common, and with very complex structures for some cases, radiative pressure from the stars can explain only a small portion of the mass-loss processes; thus the essential driving mechanism is still unknown, particularly for high-mass stars. We report on magnetic field measurements associated with the well-known extreme red supergiant, VY Canis Majoris (VY CMa). We measured the linear polarization and the Zeeman splitting of the SiO $v = 0$, $J = 1 - 0$ transition, using a sensitive radio interferometer. The measured magnetic field strengths are surprisingly high; their upper limits range between 150 and 650 Gauss within 530 AU (~ 80 R_*) of the star. The field strength of lower limit is expected to be at least ~ 10 Gauss based on the high degree of linear polarization. Since the field strengths are very high, the magnetic field must be a key element in understanding the stellar evolution of VY CMa as well as the dynamical and chemical evolution of the complex CSE of the star. M-type supergiants, with large stellar surface, were thought to be very slow rotators. This would seem to make a dynamo in operation difficult and would also dilute any fossil magnetic field. At least for VY CMa, we expect that powerful dynamo processes must still be active to generate the intense magnetic field.