Exceptional Stars Origins, Companions, Masses and Planets

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As SIM Interdisciplinary Scientist, we will study the formation, nature and planetary companions of the exotic endpoints of stellar evolution. As part of this program, we will contribute to the mission:

- A tie of the SIM frame to the ecliptic (Solar System ephemeris) frame with better than 20 microarcsec precision.
- A study of the problem of amplitude calibration for SIM, and the requirements for precision work on binary stars unresolved by the individual SIM apertures.
- A study of the effects of distant companions to grid stars, in particular on SIMs sensitivity to long-period binaries, and suggestions for avoiding these effects.

Our science begins with stars evolving from asymptotic branch giants into white dwarfs. We will determine the parallax and orbital inclination of several iron-deficient post-AGB stars, who peculiar abundances and infrared excesses are evidence that they are accreting gas depleted of dust from a circumbinary disk. Measurement of the orbital inclination, companion mass and parallax will provide critical constraints. One of these stars is a prime candidate for trying nulling observations, which should reveal light reflected from both the circumbinary and Roche disks. The circumbinary disks seem favorable sites for planet formation.

Next, we will search for planets around white dwarfs, both survivors from the main-sequence stage, and ones newly formed from the circumbinary disks of post-AGB binaries or in white dwarf mergers.

Moving up in mass, we will measure the orbital reflex of OB/Be companions to pulsars, determine natal kicks and presupernova orbits, and expand the sample of well-determined neutron star masses. We will obtain the parallax of a transient X-ray binary, whose quiescent emission may be thermal emission from the neutron star, aiming for precise measurement of the neutron star radius.

Neutron stars receive large kicks at birth. OB companions unbound by this kick become runaway OB starts. Yet some OB stars appear so high above the galactic plane they could not have gotten there in their lifetime. Some may be misidentified post-AGB stars, some may have formed 10kpc above the Galactic plane; we will find their true nature from their proper motion and parallax (or limit thereto).

A few neutron stars whose kicks are suitably oriented can remain in low-mass X-ray binaries. Proper motion and parallax measurements, combined with radial velocity, fix their true space velocities, and thus test the scenarios for their formation.

Finally, black holes. We will measure the reflex motions of the companion of what appear to be the most massive stellar black holes. The visual orbits will determine natal kicks, and test the assumptions underlying mass estimates made from the radial velocity curves, projected rotation, and ellipsoidal variations. In addition, we will attempt to observe the visual orbit of SS 433, as well as the proper motion of the emission line clumps in its relativistic jets.