Observational studies of Centaurs, interesting and transitional minor planets

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Project Description: Centaurs are a group of bodies in our Solar System that are relatively small (up to a few hundred km in diameter) and relatively distant (perihelion > 5.2 AU and semimajor axis < 30 AU). Approximately 400 objects have currently been classified as centaurs. Centaurs are currently on unstable orbits, lasting only a few million years, because they are dynamically perturbed by the giant planets. They are thought to originate from farther out in the Solar System, with a close tie to the Scattered Disk, and they eventually are either ejected, become Jupiter-family comets, or impact the giant planets. Centaurs can be considered a transitional group in a number of respects: (i) the orbits lie between those of the more distant trans-Neptunian objects and the closer asteroid belt, (ii) the colors are bimodal, either blue or very red, (iii) some centaurs have exhibited outbursting activity while others are dormant (behavior that falls between that of comets and asteroids), and (iv) small-scale ring systems have been reported or proposed for a few centaurs (a phenomenon that was previous observed only around giant planets).

This project involves optical and near-infrared observations of Centaurs in order to better characterize their physical properties. (Radio observations would also be welcome, if there are willing SKA collaborators and proper scientific motivation.) The methods of photometry, spectroscopy, and stellar occultations will be employed. The brightest centaurs can be observed using meter-class telescopes, with fainter objects and spectra requiring larger apertures. This project is based on primarily on new observations, which will be taken using some or all of following telescopes: SAAO 74 inch, 40 inch, and Lesedi; SALT; the Las Cumbres Observatory network; 3-m NASA IRTF (Hawaii); 4-m Discovery Channel Telescope (Arizona); 6.5-m Magellan (Chile). The collaborators on the project are located at MIT, which allows access to telescopes beyond those usually available to South African astronomers. The student should have the opportunity to visit MIT and work directly with the collaborators and may have the opportunity to observe on the international telescopes.

Outstanding science questions include the following:

(i) What fraction of centaurs are active?
(ii) What are the mechanisms that cause outbursting on centaurs, and how are these similar or different to comets?
(iii) Are there other centaurs that have ring systems?
(iv) What are the likely formation scenarios for centaur rings, and how do the systems evolve over time?
(v) What are the correlations between centaur surface color, outbursting, rings, and orbits?

In the 3-year period of the project, we expect to better characterize a handful of Centaurs, with the goal of specifically focusing on addressing a few of the above questions. Photometry and spectra will provide significant information, and a successful stellar occultation(s) would provide a wealth of data for a detailed investigation of coma material and ring detection/evolution.