Title:

How blind deconvolution can push further the instrumental limits? Two examples with (I) asteroid imaging and moon detection, and (II) Betelgeuse's surface recovery from its occultation by (319) Leona

Abstract:

The emergence of extreme adaptive optics (AO) systems in the last two decades pushed to unprecedented limits the resolution achievable by ground-based telescopes. Nonetheless, despite the always increasing performances of AO systems, the correction is never perfect, still degrading the images compared to the theoretical instrumental limits: (I) by exploding the point spread function (PSF) core in multiple lobes, the low wind effect degrades the performances when the observing conditions are supposed to be best, (II) wind driven halo limits the contrast achievable with coronagraphs. With their segmented pupils fragmented by large structures holding the secondary mirror, coupled to thermal and mechanical stresses and windshake, the future 30-to-40-meter class telescopes will push these problems to unprecedented levels. Analytical models, too conservative, cannot describe the resulting AO-PSFs in their full complexity, limiting the performances of post-processing algorithms. This calls for the need to recover the PSF shape directly from the scientific data of interest, a method so-called blind deconvolution. In this presentation, I will present two examples where blind deconvolution pushes instrument performances to unprecedent levels: (I) reconstruction of real AO-systems and simulated Extremely Large Telescope (ELT) PSFs in the presence of sharp-edge objects, such as resolved asteroids, without any prior on the instrument, dramatically improving the contrast to detect faint moons, (II) the recovery to Betelgeuse's surface in visible from its occultation by the asteroid (319) Leona in December 2023 observed by amateur astronomer but achieving a resolution pre-figuring the one of the ELT.