Abstract

Even today, when many large telescopes have high performance Adaptive Optics systems, speckle imaging is as important as ever to get useful high-spatial-resolution information about important astronomical objects, particularly in the detection of stellar companions of exoplanet host stars. Any methods that can extend the reach of speckle imaging to objects that are fainter or farther away would be welcome additions to the range of techniques for high-resolution imaging.

In the first part of the thesis I describe a method to do a selection of frames of an image stack from an astronomical observation done by speckle imaging, using specific Rényi entropy as a classification, that is, a decision-making tool. With this automatic selection process the signal-to-noise ratio can be improved between 15-20% in some cases, although no method could consistently provide improvement in all cases. Another implication of the study is that, by using entropy as a criterion, a sub-stack of 10 to 40% of the "best" frames in a speckle stack can often demonstrate a signal-to-noise ratio comparable to a full stack, which could minimize computation time of the reconstructed image, making it feasible to compute at the telescope.

In the second part of the thesis I describe how the data from a Shack-Hartmann sensor, as an *a priori* information source, can be used to create a better instantaneous Point-Spread-Function (PSF) that can be used to preprocess speckle data, leading to a scientific image with higher S/N and better detection limits for faint companions. This is of some importance in certain science applications of speckle imaging observations, such as the accurate measurement of the radii of exoplanets.