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Speckle interferometric observations of close binary stars

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Abstract. Speckle interferometric technique is employed to record a series of hundreds of short-exposure images of several close binary stars with sub-arcsecond separation through a narrow band filter at the Cassegrain focus of the 2.34 meter (m) Vainu Bappu Telescope (VBT), situated at Vainu Bappu Observatory (VBO), Kavalur, India. The data are recorded sequentially by a Peltier-cooled intensified CCD camera with 10 ms exposure. The auto-correlation method is applied to determine the angular separations and position angles of these binary systems.

Keywords : interferometer, speckle imaging, close binary stars

The speckle interferometer developed by Saha et al. (1999) samples the image scale at the Cassegrain focus of the VBT to 0.015″ per pixel of the Peltier-cooled intensified charge coupled device (ICCD) camera. The wavefront falls on the focal plane and passes on to a microscope objective through an aperture of ~ 350μ of an optical flat kept at an angle of 15°. The enlarged beam is recorded by the ICCD after passing through a narrow band filter. The surrounding star field of diameter ϕ 10mm, gets reflected from the optical flat on to a plane mirror and is reimaged on to an uncooled ICCD for guiding the object.

A large number of speckle-grams of several close binary stars and of reference stars were recorded on April 10, 1999 at VBT through a 10 nm filter centred on 6761 Å. These images were acquired with a Peltier-cooled ICCD camera with an exposure time of 10 ms. This camera offers options of choosing the exposure time, viz., 1 ms, 5 ms, 10 ms, 20 ms etc. It can operate in full frame, frame transfer and kinetic modes. Since the CCD is cooled to – 40°C, the dark noise is low. Data are digitized to 12 bits and can be archived to a Pentium based PC. In full frame, as well as in frame transfer modes, the region of interest can be acquired at a faster speed. While in the kinetic mode, the image can be confined to a small area.

Data of two close binary stars, HR4891 and HR5298 along with the respective reference stars were processed. The data acquired using window 3.1 software is stored in the SPE

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format. The data is then converted to FITS (16 bit unsigned integer) format. The SPE format has a fixed header size of 4100 bytes, followed by an array of 16 bit integer values, the size of which is determined by the image section used and the number of frames acquired in a single sequence.

More than 400 frames of each of the stars are scanned carefully. Some of the frames contained specklegrams whose centroid were displaced with respect to the circular pinhole image. In the case of binary stars, these images considerably reduce the visibility of the fringes in the processed image. Care was taken to select the frames in which the centroid of the specklegram was centred within the pinhole image to within 10-15 pixels. The elimination of the faulty frames in this manner improved the fringe contrast by a factor of 2. The separation of the components of HR4891 and HR5298 are found to be 0.094″ and 0.109″ respectively. These results are consistent with the CHARA catalogue. Figure 1 depicts the autocorrelation of the binary star HR5298; the companion star is imprinted on either side of the primary star.

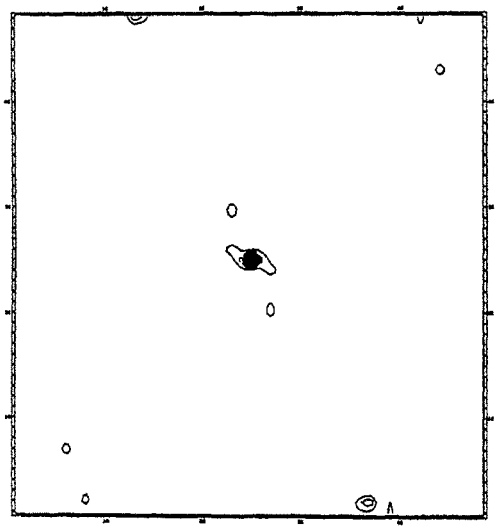

Figure 1. Autocorrelation of HR5298.

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