Bull. Astr. Soc. India (1999) **27**, 327-329

Night time variation of Fried's parameter at VBT, Kavalur

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Abstract. The night time variation of the Fried's parameter, r_0 is measured on 28-29 March 1991, at the Cassegrain focus of 2.34 m Vainu Bappu Telescope (VBT), at Vainu Bappu Observatory (VBO), Kavalur, India, using speckle interferometer; the results are discussed.

Key words : interferometer, speckle imaging, seeing, Fried's parameter.

1. Introduction

When a wavefront passes down through the atmosphere, it suffers phase fluctuations and reaches the entrance pupil of a telescope with patches of random excursions in phase (Fried, 1966). If the exposure time is shorter (< 20 ms) than the evolution time of the phase inhomogeneities, then each patch of the wavefront with diameter r_0 would act independently of the rest of the wavefront resulting in many bright spots - speckles - spread over the area defined by the long exposure image. These speckles can occur randomly along any direction within an angular patch of diameter $1.22\ \lambda/r_0$. We present here the night time variation of r_0 from the data obtained at 2.34 m VBT, at VBO, Kavalur, using speckle interferometric technique (Labeyrie, 1970).

2. Observations and data processing

We have recorded speckle-grams of 14 unresolved stars (15 data points) in and around 30° zenith with the speckle interferometer (Saha et al., 1987) on 28-29 March 1991, at the Cassegrain focus of the VBT through a 5nm filter centered on Hα using frame transfer uncooled intensified CCD (Chinnappan et al., 1991). The image at the said focus is sampled to 0.027 arcsecond per pixel. The m_v of these stars varied from 5 to 7. The observations were carried out between 1500 and 2330 hrs. UT.

The averaged autocorrelation of the short exposure images of a point source contains autocorrelation of the seeing disk together with the autocorrelation of mean speckle cell

(Wood, 1985; Saha et al., 1998). Figure 1 depicts the autocorrelation of HR 2305 observed at 1510 hrs. UT, comprising the width of the seeing disk, as well as the width of the speckle component. The size of the r_0 is found to be 8.5 cm at Hα. The form of transfer function $< |\hat{P}(r)|^2 >$ is obtained by calculating Wiener spectrum of the instantaneous intensity distribution from each of these stars. Here, $\hat{P}$ is the transfer function, r = (x,y) is a 2-dimensional space

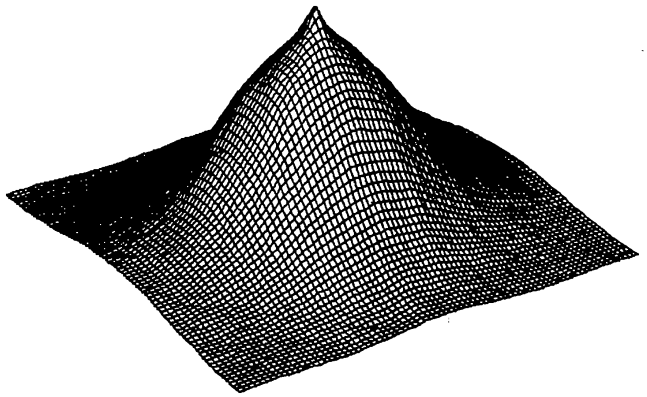

Figure 1. Autocorrelation of HR2305 observed at 1510 hrs.

vector, <> indicates the ensemble average and || the modulus. The r_0 is measured from the two speckle-grams acquired at an exposure times of 20 ms, containing odd and even fields of a single frame. The average of these frames is the instantaneous value of r_0 at the time of observation. The estimated error in this measurement is of the order of ± 0.05 arcsec. Figure 2 depicts the night time variation of r_0 on 28-29 March 1991 comprising of zenith distance corrected value (solid line) and uncorrected value.

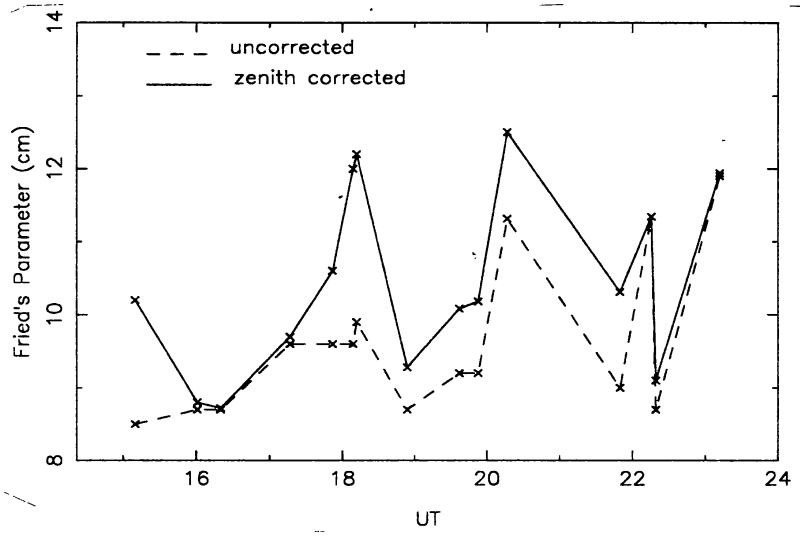

Figure 2. Night time variation of r_0 on 28-29 Mar., 1991, at VBT, Kavalur.

3. Discussion and conclusions

Systematic studies of r_0 would enable one to understand the various causes of the local seeing, for example, thermal inhomogeneities associated with the building, aberrations in the design, manufacture and alignment of the optical train, etc. The value of r_0 is an essential parameter in designing proper adaptive optics system for the telescope. It is seen from figure 2 that the seeing improves gradually in the later part of the night at an interval of several minutes. Racine (1996) too observed that the best seeing condition lasts only for several minutes. It may be necessary to maintain a uniform temperature in and around the primary mirror of the telescope to avoid the degradation of the seeing. Care has been taken while designing the new speckle interferometer (Saha et al., 1997, 1998) to avoid the formation of eddies produced by the hot air entrapment.

Depending upon the high velocity wind, the coherence time varies from <1 ms to ~ 0.1s 5% to 50% variations in r_0 are common within a few seconds; they can reach up to 100% sometimes (Foy, 1988). These variations increase the noise in the power spectrum. If the speckle pattern is not frozen enough due to the long integration time, intermediate spatial frequencies vanish rapidly. There is loss in signal-to noise ratio and loss in spatial resolution. The ICCD has fixed integration time, therefore, a photon counting system of very high time resolution of the order of a few MHz (Graves et al., 1993, Papaliolios et al., 1985) is needed to tune the integration time according to the value of r_0.

References

Chinnappan V., Saha S. K., Faseehana, 1991, Kod. Obs. bull. 11, 87.

Foy R., 1988, Proc. "Instrumentation for Ground-Based Optical Astronomy - Present and future" ed. L. Robinson, Springer-Verlag, NY, 345.

Fried D. C., 1966, J. Opt. Soc. Am., 56, 1972.

Graves J. E., Northcott M. J., Roddier C., Roddier F., Anuskiewicz J., Monet G., Rigaut F., Madec P. Y., 1993, Proc. ICO-16 Satellite Conf. On "Active and Adaptive Optics" ed. F. Merkle, Garching bei München, Germany, 47.

Labeyrie A., 1970, A&A, 6, 85.

Papaliolios C., Nisenson P., Ebstein S., 1985, App. Opt. 24, 287.

Racine R., 1996, PASP, 108, 372.

Saha S. K., Jayarajan A. P., Sudheendra G., Umesh Chandra A., 1997, BASI, 25, 379.

Saha S. K., Sudheendra G., Umesh Chandra A., Chinnappan V., 1998, Experimental Astronomy (in press).

Saha S. K. Venkatakrishnan P., Jayarajan A. P., Jayavel N., 1987, Curr. Sci. 57, 985.

Wood P. R., 1985, Proc. ASA, 6, 120.