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SIMULATION OF ANGLE-OF-ARRIVAL FLUCTUATIONS AS OBSERVED IN THE MISOLFA PUPIL PLANE

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Abstract. The MISOLFA seeing monitor is developed to analyze spatial and temporal statistical properties of daytime optical turbulence. It is based on Angle-of-Arrival (AA) statistical properties. The MISOLFA optical device measures AA-fluctuations observed as intensity variations in the pupil plane image formed through a thin slit positioned in the instrument focal plane on the solar edge. Numerical simulations are then performed to ensure the system performances. We present here its basic principles and some obtained results.

1 Introduction

MISOLFA (*Moniteur d'Images SOLaires Franco-Algérien*) is a tool for diagnosing diurnal optical turbulence. The concept of this monitor is based on Angle-of-Arrival (AA) fluctuation measurements (Irbah *et al.* 2001). They are observed by mean of two observation ways. We deduce the atmospheric turbulence parameters from AA fluctuations.

2 Pupil plane observation in MISOLFA

MISOLFA has two analysis ways. The *Image Plane way* consists in measuring apparent agitation of the solar limb directly observed on the images in the focal plane. The *Pupil Plane way* consists in observing the telescope entrance pupil through a diaphragm positioned in the focal plane on the solar edge image (Borgnino, 1978). This device reveals *Solar Flying Shadows* (Borgnino & Martin, 1977) which are pupil intensity fluctuations due to the partial masking introduced by the diaphragm on the focused light. If the intensity fluctuations observed on the reconstructed pupil image are related to the AA-fluctuations in the pupil plane then we can estimate the turbulence properties using the AA-fluctuation statistical study well theoretically established. We focuss this work on the Pupil Plane way of MISOLFA.

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3 Numerical simulation

A numerical simulation is initiated to understand the connection between the fluctuations of pupil plane intensity and the AA ones. This simulation includes the effects of atmospheric turbulence on the optical radiation and the optical ones related to the equipment. As a first study, we consider the observation of an extended object in the case of an isoplanatic optical turbulence. The near-field approximation has been assumed neglecting all scintillation effects. Various darkening profiles of the solar limb were also tested.

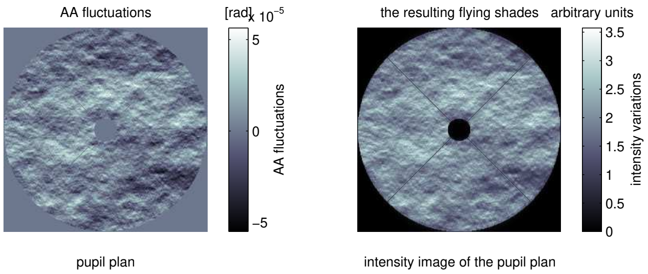

Fig. 1. Simulation of AA-fluctuations (left) and corresponding Flying Shadows in the pupil plane image (right). They were obtained for a same optical turbulence at the entrance pupil and an extended source of uniform luminosity in case of total isoplanatism. We have also assumed a very large diaphragm width neglecting the diffraction filtering.

In case of a linear darkening profile for the solar limb, it is numerically shown that the intensity fluctuations are proportional to the AA-fluctuations. On another side, the relation between the intensity and AA fluctuations is slightly non-linear if the darkening profile is strongly non-linear. However, the solar limb is almost linear over an angular extent of about the size of the seeing angle. It is the angular extent on which the diaphragm effect occurs on the incident light. We could reasonably conclude that in case of isoplanatic turbulence, intensity variations obtained in the pupil image are proportional to the AA-fluctuations at the telescope entrance pupil. Future developments will take into account other effects in the simulations like anisoplanatism and scintillation.

References

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