**Coverletter**

This article is review on author’s published papers for problem related with operation of optical systems, including adaptive system, in turbulent atmosphere under strong turbulence regime. This article is related to the peculiarity of the operation of optical systems in the atmosphere. An analysis of the features of measurements and correction of phase distortions in optical waves propagating in the atmosphere at various levels of turbulence was performed. It is shown that with increasing intensity fluctuations, the limiting capabilities of phase correction decrease, and the phase of an optical wave that has passed through a turbulence layer consists of two components: potential and vortex.

I investigated the processes occurring in the operation of the Shack-Hartmann type WFS during deep amplitude modulation of the illumination of individual spots, up to their complete fading. It turned out that a possible solution to the problem is to design the operation of the WFS using an analysis of the behavior of the focal patterns of the Hartmann sensor at various threshold illumination values, up to background values. At the same time, a comparison of the behavior of the measured mode components of phase distortions under weak and strong illumination modulations shows that the appearance of intensity fluctuations leads to parasitic modulation of the spectra of lower modes, which causes a loss of phase correction efficiency. Based on the study of the behavior of the mode components of phase fluctuations, reconstructed from measurement data under various operating modes, it was found that, first of all, the lower modes of the decomposition of phase fluctuations - tilts, defocusing and astigmatism - are subject to distortions and, as analysis shows, these modes can greatly differ from the classical ones corresponding to the regime of weak fluctuations.

One of the methods to combat the influence of scintillations can be selection to use only data from “good” subapertures to restore the phase. Also, to combat the influence of amplitude fluctuations, it is possible to use multistage phase correction using non-phase sensors to measure fluctuations in the overall slope and defocusing of the wavefront. As an implementation of this, an analysis of the illumination of the focal patterns of the Hartmann sensor was performed using various threshold illumination values, up to a value of 1.5 greater than the background. Also, to combat the influence of amplitude fluctuations, we can recommend the use of multistage phase correction using non-phase sensors to measure fluctuations in the overall slope and defocusing of the wavefront. This increases the coherence of the optical field that the WFS deals with, which reduces the effect of intensity fluctuations on the data received from the WFS.

As for the random signal fading that occurs during the operation of the WF AO system in the region of “strong” fluctuations, when large-scale and long-term continuous signal fading is possible, further in-depth studies are required to explain this.