INSTANTANEOUS INTERFERENCE IMAGES AND THE MANIFESTATION OF THE SPATIAL COHERENCE OF LIGHT WITH WIDE FREQUENCY AND ANGULAR SPECTRA IN AN INTERFERENCE EXPERIMENT

L.A. Maksimova, N.Y. Mysina, V.P. Ryabukho

Institute of Precision Mechanics and Control, Russian Academy of Sciences, Russia, г. Saratov

Saratov State University, Russia

Coherent effects in the formation of interference images in microscope in quasi-monochromatic or frequency-broadband light (white light) with a wide angular spectrum (wide angular aperture) are considered. The instantaneous interference images with an instantaneous speckle structure were simulated on a computer and the effect of the width of the angular and frequency spectra of the optical wave field on the contrast of the interference fringes observed in the experiment was investigated.

$$E(x,y)=\sum_{j=-NA}^{NA}\sum_{k=-NA}^{NA}E_0\exp\left(i2\pi\left(\frac{x}{\Lambda_x}+\frac{y}{\Lambda_y}\right)+\Delta\varphi_0\right)\left(1-\exp\left(i2\pi\frac{\Delta(x,y)}{\lambda}\right)\right)$$

$E(x,y)$ – distribution of amplitude of field in interference fringes formed in a thin layer;
$\Delta(x,y)$ – optical path difference of waves passing through the thin layer and reflected from the surface (Fig. 1a);
NA – numerical aperture of extended source

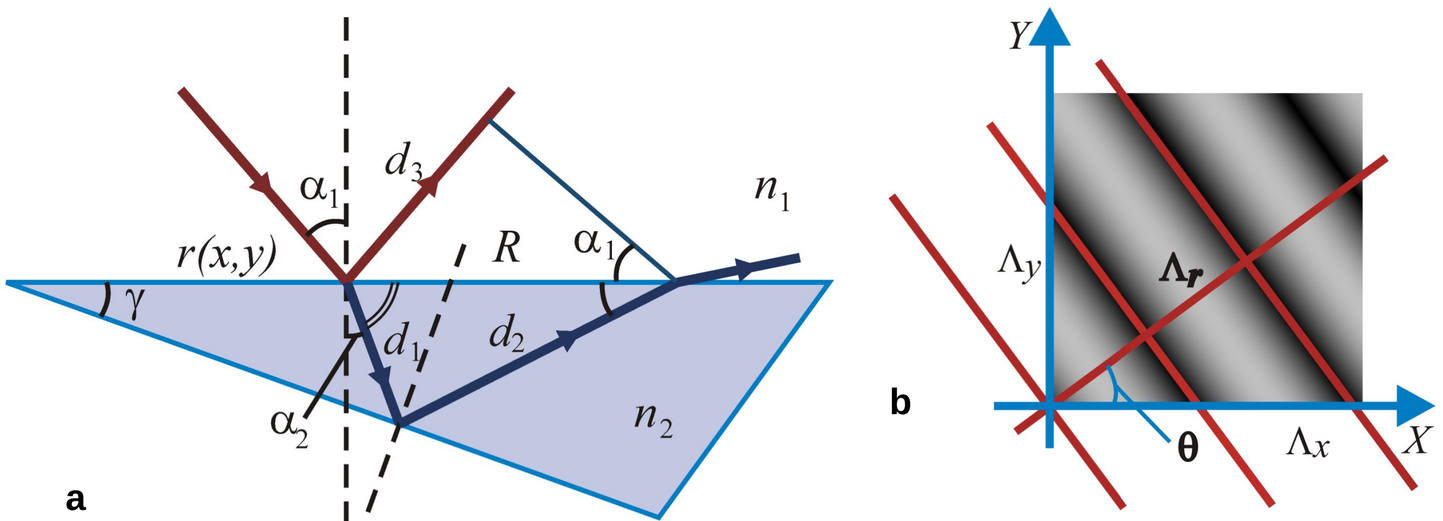


Fig.1. Rays propagation in a thin layer (**a**); fragment of the field distribution in the plane of incidence of one component of the light wave (**b**)

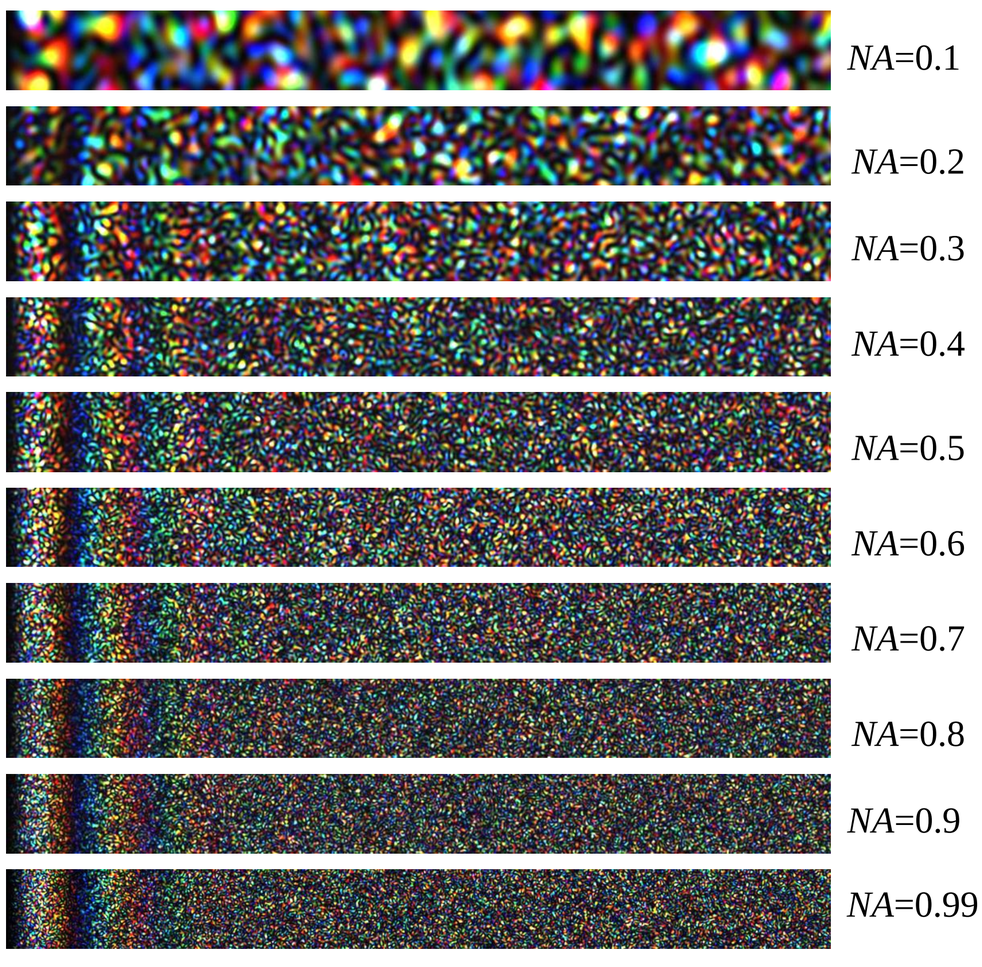


Fig. 2. Speckle-modulated interference fringes in thin layer (n_2=1.5, γ=0,02) with using an extended polychromatic source with (λ_0=0,55 μm, Δλ=0,38÷0,76 μm) at different numerical aperture NA of the illumination field

Fig.4. Influence of the width of the frequency spectrum of the interfering wave fields on decorrelation of the fields and the visibility of interference fringes

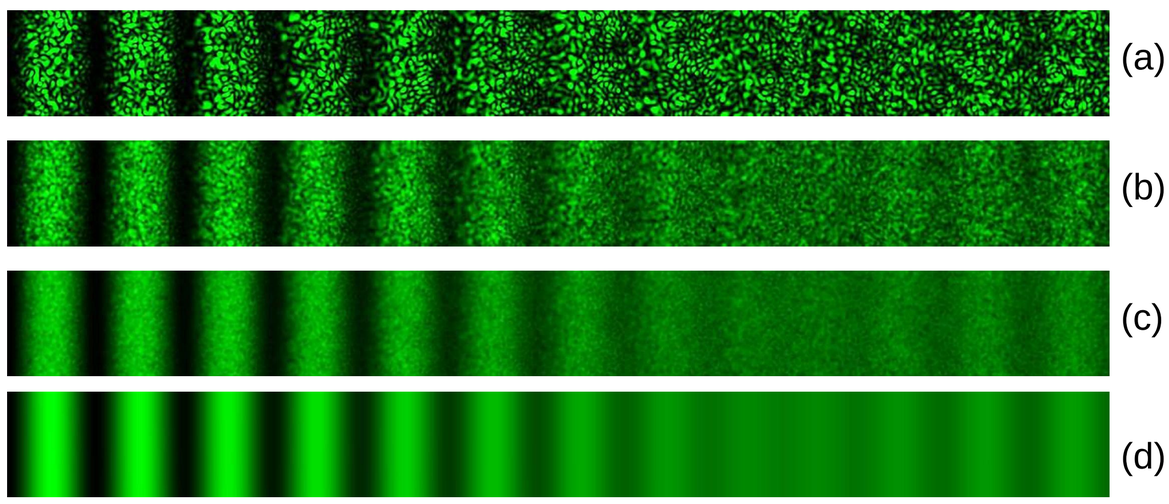
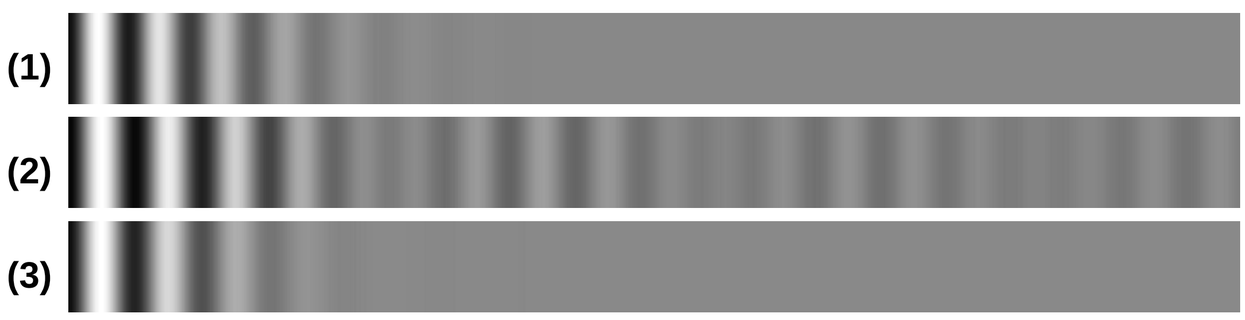


Fig. 3. Speckle-modulated interference fringes in thin layer (n_2=1.5, γ=0,02 rad, λ=0,55 μm,): **a** – non-averaged fringes; **b, c** – fringes averaged over the ensemble of N realizations: **b** – N=10, **c** – N=100; **d** – fringes as the sum of the interference patterns of all angular components



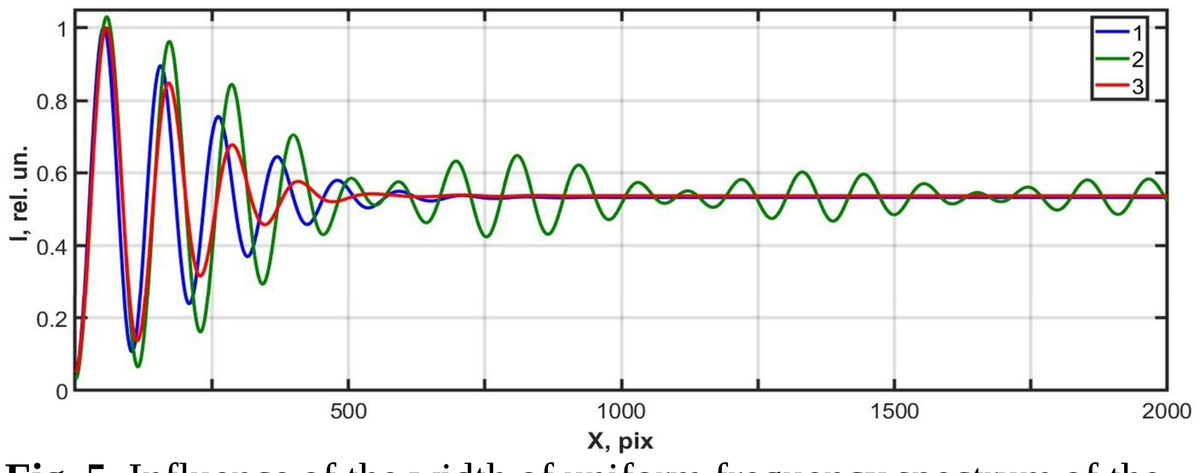


Fig. 5. Influence of the width of uniform frequency spectrum of the field with NA=0, Δλ=0,43÷0,83 μm, λ_o=0,63 μm (**1**), spatially-frequency component of the field with NA=0.9, Δλ=0, λ_o=0,63 μm (**2**) and the total effect of these spectra: NA=0,9, Δλ=0,43÷0,83 μm, λ_o=0,63 μm (**3**) on reducing the visibility of interference fringes in thin layer and the intensity distribution in the pattern