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Title of the thesis: "*Studies of Partially coherent Optical Fields and their Applications*"

Abstract of thesis

The present thesis lays emphasis on the "*Studies of Partially coherent Optical Fields and their Applications*".
In general, the light sources belong to one of the two well defined categories, i.e., coherent and incoherent. The emission from incoherent sources is a highly disordered process as in thermal sources, while the emission from coherent sources is in a very ordered manner as in the case of lasers. Statistically, the coherent and incoherent sources are the extremes, but in practice, light sources or fields are neither completely coherent nor completely incoherent, they are partially coherent. All the light fields have random fluctuations to some extent because of several causes. This randomness cannot be completely eliminated from the light fields. In every light field these random fluctuations are correlated with each other and are described by various correlation functions. The optical coherence theory deals with these correlation functions. Within the framework of classical scalar theory, the correlation functions that characterize the statistical properties of the sources and of the partially coherent fields they generate, may be described in the space-time domain. After extensive research on optical coherence, these correlation functions are described in space-frequency domain, which give rise to different coherence phenomenon and predictions of new effects.

On propagation of light radiation through space, the correlation property of the optical field changes, this is the well known van-Cittert Zernike theorem. It was also shown that the change in the correlation properties of the light fields leads to changes in the spectral properties of the source and is known as the *Wolf effect*. It states that, if the correlation property of the light source violates the so called scaling law, the spectral properties change during propagation. The scaling law states that any change in the correlation property of the source by change in the wavelength of the light source if, is compensated by the change in the position vector of the two source points between which the correlation property is being

measured. The phenomenon that the spectral changes came from the spectral correlation of the source is also termed as the correlation-induced spectral changes and has been verified by a number of experiments. It was also shown that when a light field which satisfies the scaling law, is incident upon an aperture, the diffraction of the field by the aperture will make the spectrum of light in the diffraction field (in the far zone), different from that at the aperture. The changes in the spectrum are due to the diffraction effect, thus it is said to be the diffraction induced spectral changes. It was found that when a field that satisfies the scaling law and is diffracted by a circular aperture, the spectral changes occur in the diffraction field, and at one side of special distances, a spectral line becomes red shifted, at the other side becomes blue shifted, and break into two lines at the special distance. This phenomenon was termed as *spectral switching* and it has been verified experimentally.

Both the coherence-induced spectral changes and the diffraction-induced spectral changes of partially coherent optical fields have many applications. This thesis presents a review of fundamentals of partially coherent optical fields and different applications of the partially coherent light fields in different areas.

Some significant aspects of the work are listed below:

- A detailed study is carried out for the effect of astigmatism on the spectral switches of spatially partially coherent polychromatic light. The experimental observations are discussed in detail and the application of the study is also explored.
- A new technique for information processing in free-space using spectral switching phenomenon is explored. The advantages and limitations of the technique are also discussed.
- An experimental study is carried out to explore the possibility of using spectral interferometric method for the determination of surface flatness of the optical flats.
- Partially coherent optical bottle beams are generated which might be used as partially coherent optical trap for the trapping of different elements.