Atmospheric detection applying Laguerre optics to femtosecond lasers

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Development of new femtosecond lasers has revolutionized the active remote sensing systems. Detection techniques based on light detection and ranging (LIDAR) have significantly improved thanks to this laser features. All instruments based on LIDAR use a laser that transmits light out to a target. This light interacts with and is reflected or scattered back to the instrument where it is analyzed. Changes in the properties of the light enable to determine some characteristics of the target.

Different kinds of lasers are used depending on what is intended to measure. A very important field of application has been found in the atmosphere. The worrying levels of pollution and aerosol have made necessary the study of ozone profile, atmospheric ozone, solar radiation, terrestrial radiation, etc. The presence of elements in the atmosphere, such as ozone (O3), oxygen (O2/O4), nitrogen dioxide (NO2), sulphur dioxide (SO2), chlorine monoxide (ClO) or chlorine dioxide (ClO2) can be detected using light in the infrared spectrum (from 700 nm to 350um). Each component has a different response to wavelength, what allows determining if it appears and in what concentration.

At the same time, the development of lasers, specially those that generate ultrashort pulses, obtains higher power levels, higher spatial resolution and less distortion on the measurement, producing better results. They allow dynamic analysis in real time of chemical reactions and studies of ultrashort physics processes, something not possible until now.

The purpose of this paper is not only for making a proposal for femtosecond lasers to be used in the infrared range for atmospheric detection and for exposing the advantages that they offer, but also for analyzing the effects of using ultrashort pulses applying Laguerre optics in dispersive media. Surprisingly the obtained results show that, using this mathematical model and in these conditions, the reflection and refraction equations change. If these changes were applied to elements detection, the achieved results could help to improve the existing techniques used in teledetection.