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# Optical propagation of fractal fields. Experimental analysis in a single display

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**Abstract.** An experimental device to show in a single display all the diffraction patterns generated by a 1D fractal structure is proposed. It is found that in addition to being the optimum display to see the evolution of the diffracted field through free space, some interesting features, such as continuous evaluation of self-similarity from the object to the far field, can be obtained experimentally.

## 1. Introduction

Many natural phenomena and physical structures, such as phase transition, turbulence, or optical textures, can be analysed and described using the fractal approach [1]. For this reason, the properties of diffraction patterns produced by fractal objects and their potential applications have attracted the attention of several researchers during recent years. Most research has been devoted to the study of diffraction properties of fractals in the Fraunhofer region [2, 3] but there are only a few studies concerning Fresnel diffraction. In [4] it was numerically demonstrated that during Fresnel diffraction of a Cantor set, the irradiance distributions along the optical axis have a periodicity that depends on the level of the set. In the same reference it was also shown that the intensity distributions at transverse planes show a partial self-similar behaviour which is increased when moving towards the Fraunhofer region. In [5], evolution of the complex amplitude of a Cantor fractal propagating through free space was also numerically evaluated and represented in a two-dimensional display where one axis is the transversal coordinate and the other is a certain bounded function of the axial coordinate. This kind of two-dimensional representation has been shown very useful since it contains most of the relevant information about the diffraction patterns of such objects. However, to our knowledge there is no experimental setup designed to obtain them. In this work an optical arrangement is proposed to visualize all the diffraction patterns generated by a fractal structure simultaneously in a single display. Additionally it is shown that some interesting features of fractals, such as evolution of self-similarity under propagation, can be obtained from this experimental result. Comparisons between numerical and experimental results show the good performance of the proposed arrangement.

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