Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Engineering structured light with Vogel spiral arrays of nanoparticles NATE LAWRENCE, Department of Electrical Engineering, Boston University, JACOB TREVINO, Division of Material Science, Boston University, LUCA DAL NEGRO, Department of Electrical Engineering, Boston University — We present a general analytical model for light scattering by arbitrary Vogel spiral arrays of circular apertures uniformly illuminated at normal incidence. This model suffices to unveil the fundamental mathematical structure of their complex Fraunhofer diffraction patterns and enables the engineering of optical beams carrying multiple values of orbital angular momentum (OAM). By performing analytical Fourier-Hankel decomposition of spiral arrays and far field patterns, we rigorously demonstrate the ability to encode specific numerical sequences onto the OAM values of diffracted optical beams. In particular, we show that these OAM values are determined by the rational approximations of the continued fraction expansions of the irrational angles utilized to generate Vogel spirals. Finally, we experimentally demonstrate structured light carrying multiple values of OAM in the far-field scattering region of Vogel spiral arrays of metallic nanoparticles. Using Fourier-Hankel mode decomposition analysis and interferometric reconstruction of the complex amplitude of scattered waves, we show the ability to encode well-defined numerical sequences, determined by the aperiodic spiral geometry, into azimuthal OAM values, in excellent agreement with analytical scattering theory. The generation of sequences of OAM values by light scattering from engineered aperiodic surfaces is relevant to a number of device applications for secure optical communication, classical and quantum cryptography.

Nate Lawrence
Department of Electrical Engineering, Boston University

Date submitted: 09 Nov 2012 Electronic form version 1.4