High-NA optical vortex coronagraphy

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In the current study we prove that umbilic-like defects can be used for high NA coronagraphy. Modern q-plates are good in the case of low-NA coronagraphy but they don't cover the range of high-NA due to the limits coming from their process of fabrication. In contrast, umbilic-like defects which are created in liquid crystal (LC) cells under the applied voltage don't have such limitations and their defect size can be tens or hundreds of nanometers depending on the cell and LC characteristics and the applied voltage as well. 'Natural' umbilic-like defect coronagraphy have been compared with the q-plate coronagraphy and it was proven that the umbilics are effective in both low and high NA cases, meanwhile, q-plates are only showing good results in the case of low NA. 10um liquid crystal cell has been used to generate the defects under 7.5-25V applied voltage and l = 1 q-plate with the 3um defect size has been used for q-plate coronagraphy. Ring of fire (ROF) and star and planet images in the regime of low NA for the q-plate sample have been taken. In the case of high NA (beam waist size is bigger than the q-plate defect size), ring of fire of q-plate disappears, thus, coronagraphy effectiveness drops drastically. Meanwhile, umbilics ROF is undistorted, because its defect size for 25V voltage is a few hundred of nanometers. In the regime of high NA both ROFs and star and planet images for both samples have been compared. Measurements also include dependence of the azimuthal average of the ROF intensity on the first objective NA for both samples and umbilics ROF dependence on the applied voltage.

Keywords: coronagraphy, high-NA, defects, umbilics, q-plate

Area: ***Innovative imaging***