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## Evidence of cosmic strings by the observation of the alignment of quasar polarization axes on Mpc scale

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The recently found alignment of the polarization axes of quasars in large quasar groups on Mpc scales can be explained by general relativistic cosmic string networks. By considering the cosmic string as remnant of a spontaneous symmetry breaking of the U (1) abelian Higgs model with topological charge n, many stability features of the n-vortex solutions of superconductivity can be taken over. Decay of the high multiplicity (n) super-conducting vortex into a lattice of n vortices of unit magnetic flux is energetically favorable. The temporarily broken axial symmetry will leave an imprint of a preferred azimuthal angle on the lattice. The stability of the lattice depends critically on the parameters of the model, especially when gravity comes into play. In order to handle the strong nonlinear behavior of the time-dependent coupled field equations of gravity and the scalar-gauge field, we will use a high-frequency approximation scheme to second order on a warped 5D axially symmetric spacetime with the scalar-gauge field residing on the brane. We considered different winding numbers for the subsequent orders of perturbations of the scalar field. A profound contribution to the energy momentum tensor comes from the bulk spacetime and can be understood as "dark"-energy. The cosmic string becomes super-massive by the contribution of the 5D Weyl tensor on the brane and the stored azimuthal preferences will not fade away. The recovery of the axial SO (2) symmetry will release gravitational and electro-magnetic radiation. The perturbative appearance of a non-zero energy-momentum component $T_{t\varphi}$ can be compared with the phenomenon of bifurcation along the Maclaurin-Jacobi sequence of equilibrium ellipsoids of self-gravitating compact objects accompanied by spontaneous symmetry breaking similar to the second order phase transition in type II superconductivity. The recovery of the SO (2) symmetry from the equatorial eccentricity takes place on a time-scale comparable with the emission of gravitational waves. The emergent azimuthal angle dependency in our model can be used to explain the aligned polarization axes in large quasar groups on Mpc scales. Spin axis direction perpendicular to the major axes of large quasar groups when the richness decreases, can be explained as a second order effect in our approximation scheme by the higher multiplicity terms. The preferred directions are modulo $\pi/i$ with i an integer dependent on the i-th order of approximation. When more data of quasars of high redshift will become available, then one could proof that the alignment emerged just after the symmetry breaking scale and must be of a cosmological origin. The effect of the warp factor on the second-order perturbations could also be an indication of the existence of large extra dimensions.

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