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Cosmic ray propagation around the Sun

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The Sun shadow can be measured with the IceCube detector and varies in depth corresponding to the magnetic field. Hence, we are given a possibility to understand cosmic ray propagation in the magnetic field of the Sun, for which a sufficiently good modelling is necessary. We investigate the field with its temporal deviations in strength and orientation. In times of low solar activity, the field can be approximated by a dipole structure. During higher activities, however, the field becomes increasingly inhomogeneous, especially in regions near the solar surface. These regions are spatially constrained and can reach magnetic field strengths of up to 50 Gauss. In this work, we simulate protons with energies up to $E_{p, \text{max}} = 40$ TeV. This energy is the median energy of those cosmic rays that are used in IceCube's Sun shadow analysis. Its data allows to determine the Sun shadow at different times in the solar cycle and compare the results to our simulation. We obtain solar magnetic field data within the PFSS model from the GONG data archive.

Authors: KROLL, Mike (Ruhr-Universität Bochum); TJUS, Julia; DESIATI, Paolo (University of Wisconsin - Madison); Mr TENHOLT, Frederik (Ruhr-Universität Bochum)

Presenter: KROLL, Mike (Ruhr-Universität Bochum)

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