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Evolution of the internal structure of CME flux ropes from the Sun to 1AU

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The internal magnetic structure of flux ropes carried by Coronal Mass Ejections (CMEs) is investigated by means of a 3-D theoretical reconstruction model based on the so-called Grad-Shafranov equation. The CME dynamic evolution from the Sun to 1AU is retrieved from an adapted version of the model introduced by CHEN (1996). Integration of the Grad-Shafranov equation in this approach to describe the internal field reveals significant asymmetries with a displacement of magnetic flux surfaces, also known as the Shafranov shift, towards the leading edge of the CME. Despite this shift, the internal distribution of the magnetic field derived by the model still exhibits a larger magnetic field on the inner edge of the flux rope than what is typically recorded insitu by heliospheric probes. We find that the Shafranov shift appears to be insufficient to balance and reverse the flux rope asymmetries measured in situ. We conclude that the strong magnetic fields on the leading edge of CME flux ropes measured in situ is likely the result of other effects such as the dynamic interaction of magnetic flux ropes with the background solar wind. We investigate this effect by means of full 3-D MHD simulations of CMEs propagating from Sun to Earth. The development of asymmetries in the internal magnetic field structure of CMEs near the Sun will soon be studied in great detail by Parker Solar Probe.