Analytical and numerical study of dynamics of self-similarly evolving magnetic clouds

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Magnetic clouds (MC) are "magnetized plasma clouds" moving in the solar wind. MCs transport magnetic flux and helicity from the Sun. These structures present signature of evolution in time. In our study, MCs are considered as cylindrically symmetric magnetic structures with low plasma β. In order to describe the dynamics of MCs we seek for self-similar solutions of the MHD equations. We consider longitudinal and radial expansion of MCs, and as a particular case only radial expansion is described. Also it is shown that in the self-similarly evolving, cylindrically symmetric magnetic structure the forces are balanced. We have derived explicit analytical expressions for magnetic field, plasma velocity, density and pressure. The solutions obtained here are characterized by conserved values of magnetic flux and helicity. The dynamics of self-similarly evolving MCs was investigated using the numerical code "graale". The MCs expansion in a medium with higher pressure and higher plasma β was studied. It was shown that physical parameters maintain self-similar character.