Cavities under coronal helmet streamers have been observed for many decades and are known to be correlated with CMEs. It is believed that the large amounts of energy stored in cavities’ helical magnetic fields may help power CMEs. Sometimes cavities are short-lived, but they often exist as long-term structures that last for days or weeks at a time. Unfortunately, it is very difficult to observe cavity material because surrounding features project into the line of sight and contaminate measurements. The goal of this project is to find a case in which contributions from surrounding material can be minimized, so that we can determine the density of cavity material.

The actual height $R_{\text{plasma}}$ along the line of sight as a function of the angle to the line of sight. The height $R_{\text{pos}}$ of the line of sight is given by the y-intercept of the curve. Material from higher up projects into the line of sight when it is at the appropriate scattering angle. Material from below $R_{\text{pos}}$ can never project into the line of sight and contaminate measurements. The goal is to observe cavity material because surrounding features project into the line of sight.

To determine cavity density from polarized brightness measurements we use a Van de Hulst of inversion of polarized brightness. The inversion assumes the cylindrical symmetry of objects along the line of sight. Due to the density change from cavity to rim, the cylindrical symmetry does not exist. The inversion requires the value of $R_{\text{max}}$ but the measured value is $R_{\text{pos}}=1.25$. Therefore, most light comes from the cavity and not the cavity rim when determining the center of the cavity.

Geometry of the model. The angle $\theta$ is the angle of scattering angle of a point. The angle $\phi$ is the longitude of the pole. The distance $R_{\text{cav}}$ is the actual height of the pole $P$ from the center of the Sun. The Sun and cavity as viewed from Earth. The distance from the center of the Sun to the center of the cavity is $1+R_{\text{cav}}$. $R_{\text{cav}}$ is the height of the pole of the disk through which the line of sight passes. The angle $\theta$ is the colatitude of the cavity.

Cavity properties for each date of observation. The table also lists the actual $R_{\text{max}}$ and $R_{\text{cav}}$ indicate the scattering angle and longitude of the edge of the cavity for $R_{\text{max}}$. The number of days a cavity must maintain constant latitude and size before and after an observation for our model to hold true. The table also lists the actual number of days the cavity maintain constant latitude and size.

Cavity density profiles for each date of observation. The blue error bars are centered on the measurement points and indicate the uncertainties added to the measurements by the method described above. The blue error bars are centered on the line of best fit and indicate the uncertainty in the fit. This uncertainty is passed through to the density calculation. The curves below a linear fit correspond to a lower limit of the form $p\mu=0$. The radial $\mu$ index represents the $\mu$ value at which the measurement lies. The red error bars are centered on the measurement points and indicate the uncertainties added to the measurements by the method described above. The blue error bars are centered on the line of best fit and indicate the uncertainty in the fit. This uncertainty is passed through to the density calculation. The curves below a linear fit correspond to a lower limit of the form $p\mu=0$. The radial $\mu$ index represents the $\mu$ value at which the measurement lies.

Results

- Radial polarized brightness (top) and density (bottom) profile for the cavity (black) and cavity rim (blue) on January 27. The radial polarized brightness measurements show that the cavity density is lower than the cavity rim density.
- The density profile of the cavity at the center of the cavity is 2.5 times as dense as the cavity rim.

Conclusions

- The cavity is roughly 2 to 5 times as dense as a coronal hole and has higher density by about $2\times10^4$ g/cm$^3$.
- If temperature is constant between cavity and cavity rim, lower cavity density and shallower fall off imply increased magnetic field strength and slower magnetic fall off within cavity.
- Determining cavity density should be applied using EIT data to estimate cavity temperature profile.

Abstract

Cavities in coronal helmet streamers can easily be seen in white light corona images. However, they are difficult to observe without contamination from the obstructing presence of features along the line of sight such as the helmet streamer surrounding the cavity. Our goal is to find cases where such spurious non-cavity contributions are minimal, and can be incorporated in a density analysis as conservatively estimated uncertainties in the data. To that end, we present a model of coronal cavities in which a cavity exists as an axisymmetric isothermal torus that encircles the Sun at constant latitude. We incorporate in a density analysis as conservatively estimated uncertainties in the data. To that end, we present a model of coronal cavities in which a cavity exists as an axisymmetric isothermal torus that encircles the Sun at constant latitude. We will determine the temperature profile from cavity densities estimated from cavity brightnesses. The curves assume a spherically symmetric density that falls off as $r^{-7}$.

References

- Van de Hulst, H.C. 1950, Bulletin of the Astronomical Institutes of the Netherlands, 11, 135

System

- The system is a helical magnetic field that encircles the Sun at constant latitude. The field lines are connected to each other by the streamer that encircles the Sun.
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Model

- The model is a spherically symmetric density that falls off as $r^{-7}$.
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Method

- The method is to determine cavity density from polarized brightness measurements using a Van de Hulst of inversion. The inversion assumes the cylindrical symmetry of objects along the line of sight. Due to the density change from cavity to rim, the cylindrical symmetry does not exist. The inversion requires the value of $R_{\text{max}}$, but the measured value is $R_{\text{pos}}=1.25$. Therefore, most light comes from the cavity and not the cavity rim when determining the center of the cavity.
- The method is to determine cavity density from polarized brightness measurements using a Van de Hulst of inversion. The inversion assumes the cylindrical symmetry of objects along the line of sight. Due to the density change from cavity to rim, the cylindrical symmetry does not exist. The inversion requires the value of $R_{\text{max}}$, but the measured value is $R_{\text{pos}}=1.25$. Therefore, most light comes from the cavity and not the cavity rim when determining the center of the cavity.