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Determining the axis orientation of cylindrical magnetic flux rope

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We develop a new simple method for inferring the orientation of a magnetic flux rope, which is assumed to be a time-independent cylindrically symmetric structure via the direct single-point analysis of magnetic field structure. The model tests demonstrate that, for the cylindrical flux rope regardless of whether it is force-free or not, the method can consistently yield the axis orientation of the flux rope with higher accuracy and stability than the minimum variance analysis of the magnetic field and the Grad-Shafranov reconstruction technique. Moreover, the radial distance to the axis center and the current density can also be estimated consistently. Application to two actual flux transfer events observed by the four satellites of the Cluster mission demonstrates that the method is more appropriate to be used for the inner part of flux rope, which might be closer to the cylindrical structure, showing good agreement with the results obtained from the optimal Grad-Shafranov reconstruction and the least squares technique of Faraday's law, but fails to produce such agreement for the outer satellite that grazes the flux rope. Therefore, the method must be used with caution.