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Investigating the latitudinal-dependent solar differential rotation rate using SDO/HMI Dopplergrams

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The solar photospheric differential rotation rate has novel implications to the structure of the heliospheric magnetic field. The period of the solar poles is ~ 35 days, and ~ 25 days at the equator. In this study, the Doppler shift (either blue or red) of 116 Dopplergrams from the Helioseismic and Magnetic Imager instrument on board the Solar Dynamics Observatory are investigated to experimentally determine the photospheric differential rotation rate at different solar latitudes. A model is developed to describe the variation of surface speed with solar latitude. The results are compared to well-established models in the literature and shows strong consistency in trend and behaviour. The findings confirm the latitudinal differential rotation of the Sun. The developed model shows a deviation of less than 10% when compared to established models in the literature, demonstrating its accuracy and consistency. This is particularly significant considering the difference in time scales, with the models in the literature using data spanning more than a decade, compared to the model developed using approximately an hour and a half of collected data. This study not only confirms the theoretical expectations regarding solar rotation but also demonstrates the effectiveness of Doppler spectroscopic analysis and space-based solar observations in studying solar dynamics. The results contribute to a broader understanding of solar behaviour.

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Primary author: ZULU, Thembalethu

Co-author: Dr STEYN, Ruhann (Supervisor)

Presenter: ZULU, Thembalethu

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