A SOLAR DYNAMO PREDICTION: CYCLE 23 ~ CYCLE 22

Kenneth H. Schatten (NASA/GSFC) and W. Dean Pesnell (ARC)

We briefly review the "dynamo" and "geomagnetic precursor" methods of long-term solar activity forecasting. These methods depend upon the most basic aspect of dynamo theory to predict future activity, namely future magnetic field arises directly from the magnification of pre-existing magnetic field. We then generalize the dynamo technique, allowing the method to be utilized at any phase of the solar cycle, through the development of the "Solar Dynamo Amplitude" (SODA) index. This index is chosen to be sensitive to the magnetic flux trapped within the Sun's convection zone but insensitive to the phase of the solar cycle. Since magnetic fields inside the Sun can become buoyant, one may think of the acronym SODA as describing the amount of buoyant flux. Using the present value of the SODA index, we estimate that the next cycle's smoothed peak activity will be about 210 ± 30 solar flux units for the 10.7 cm radio flux and a sunspot number of 170 ± 25. This suggests that solar cycle #23 will be large, comparable to cycle #22. The estimated peak is expected to occur near 1999.7 ± 1 year. Since the current approach is novel (using data prior to solar minimum), these estimates may improve when the upcoming solar minimum is reached.

Evolution of the Large Scale Structure of the Solar Corona, 1965-1992

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A series of three imaging K-coronameter systems have been used to monitor the structure and evolution of the lower solar corona, at altitudes of 1.3 to 1.5 solar radii from the visible limb, for a 27.2-year period beginning in 1965. Analysis of this data set demonstrates three aspects of the long term variability of the sun's outer atmosphere: (1) Some of the largest spatial scale structure demonstrates evolution on a time scale which is long compared with the rotational period of the sun. (2) Over the period of observation the polarized brightness distribution of the large-scale corona exhibited a periodic zonal variation which was not symmetric about the rotation equator of the sun. (3) Suppression of the axisymmetric zonal polarized brightness distribution reveals the existence of a persistent sectoral structure.

The second point is interpreted as being consistent with the hypothesis that an approximately periodic magnetic variation is superposed on the traditional large-scale magnetic cycle (22-year) zonal magnetic field evolution. This perturbation is qualitatively consistent with the existence of a variable zonal quadrupolar field with a period of approximately half of the 22-year magnetic cycle. The third point is consistent with the existence of a semi-permanent east-west asymmetry in the large-scale magnetic field.

Changes in the Bolometric Contrast of Sunspots

G.A. Chapman, A.M. Cookson, J.J. Dobias (SFO/SCSUN)

We report on photometric observations of sunspots carried out with the Cartesian Full Disk Telescope (CFDT) at the San Fernando Observatory (SFO). The pixel size is 5.1 arc-sec and the wavelength for the data discussed here is 6723 A. Fluctuations in total solar irradiance due to sunspots are often modeled using a constant value of alpha, which we are calling the bolometric contrast of a sunspot. We have defined $\alpha$ as $DEF/(2 \times PSI)$, where $DEF$ is the sunspot's photometric deficit relative to the quiet photosphere, and $PSI$ is the digitally determined Photometric Sunspot Index (Willson et al., 1981). For 40 sunspot groups, we find that $\alpha = 0.276 \pm 0.051 + (3.22 \pm 0.34) 10^{-6} \bar{A}$, where $\bar{A}$ is the corrected area of the sunspot in micro-hemispheres. The coefficient of determination is $r^2 = 0.1596$, which is significant at the $p = 0.005$ level. We also find that $\alpha$ is highly correlated with the ratio of umbral to total spot area $(\bar{A}_u/\bar{A})$. For 86 sunspot-days we find $\alpha = (0.219 \pm 0.018) + (0.643 \pm 0.028)(\bar{A}_u/\bar{A})$, with the linear coefficient of determination $r^2 = 0.859$. This suggests that an improved PSI can be constructed from knowledge of a sunspot's umbral to total area ratio. The use of such an improved PSI or, better still, actual photometry should reduce the statistical noise in comparisons with spacecraft measurements of the total solar irradiance. This work has been partially supported by grants from NSF and NASA.

Session 26: Molecular Cloud Structure and Energetics

Oral Session, 10:15-11:45 am

Crystal Forum

Large Scale Structure, Kinematics, and Temperature Distribution of the Orion Ridge

J.J. Wiseman, P.T.P. Ho (CFA)

We present a high resolution VLA study of the 0.5 pc extended OMC-1 molecular ridge surrounding the Orion BN/KL core of high mass star formation. Molecular streamers based in the BN/KL core region have previously been reported in this region. To clarify the structure and kinematics of the region, we have used the VLA to observe with high (0.3 km s$^{-1}$) velocity resolution and high (9") angular resolution the NH$_3$(1,1) and (2,2) rotation-inversion lines over 20 adjacent fields covering a 3' by 9' region encompassing the Kleinman-Low (KL) nebula. We present a linear mosaic of these fields, which show an abundance of structural, kinematical, and temperature information. Techniques and challenges encountered while mosaicing the interferometric maps are discussed. We find evidence of extended clumpy filaments. The component fragments display velocity gradients in varying directions; some may be sites of young stars or collapsing cores which have not yet shed their angular momentum. We also find material with velocities differing by more than 2 km s$^{-1}$ present within small projected areas, complicating simple global rotation models for OMC-1. These bimodal velocity components appear to overlap in the BN/KL active core region, suggesting cloud collision as a possible triggering mechanism. We also present a temperature map of the ridge. There is evidence for large scale (0.5 pc) outflows originating from the KL core and extending along the filaments, with possible shock heating and interaction. We discuss the likelihood of instability and fragmentation along the filaments. These observations provide an interesting case study of the active interaction between a core of high mass star formation and its molecular cloud environment.

Linear Waves and Gravitational Instability in Molecular Cloud Filaments

C. S. Gehman, F. C. Adams, M. Fatuzzo, R. Watkins (University of Michigan, Ann Arbor)

We study axial density wave propagation along self-gravitating fluid filaments, such as those found in molecular cloud complexes. We also study the linear stability of such filaments. Using the isothermal homogenous nonlinear equilibrium of a self-gravitating cylindrically symmetric fluid, we perturb the equilib-