

Física Solar

APLICAÇÃO DE CAMPOS MAGNÉTICOS LIVRES DE FORÇA NA EXPLOSÃO SOLAR DE 13 DE DEZEMBRO DE 2006

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Apresentamos os resultados da análise combinada do campo magnético e da emissão em microondas de uma explosão solar ocorrida na região ativa NOAA 10930 em 13 de Dezembro de 2006. O objetivo do trabalho foi testar a aplicação do modelo do campo magnético livre de forças aos cálculos dos coeficientes da emissão girossincrotrônica quando observações são usadas para determinar esse campo. Buscamos reproduzir as características da emissão em duas frequências observadas considerando dois instantes do evento e admitindo a manutenção da estrutura magnética durante este período. A determinação da melhor configuração magnética foi feita por comparação com observações no ultravioleta extremo (171 Å) e em microondas (17 e 34 GHz). Aplicamos o campo extrapolado aos códigos de cálculo dos coeficientes de emissão e absorção girossincrotrônicos, obtendo os demais parâmetros necessários das observações ou da literatura. Os coeficientes obtidos foram usados na transferência radiativa para reproduzir o mapa de brilho da região emissora. Os resultados reproduzem satisfatoriamente características como tamanho e forma da região emissora em microondas. A configuração magnética que melhor reproduziu as características observacionais atingiu alturas máximas de $1,5 \times 10^9$ cm e caracterizou-se por ser um campo altamente retorcido. A localização dos pés do arco magnético coincidiu com os núcleos de emissão na banda G, normalmente associada a regiões de campo intenso.

GRADIENT SPECTRAL ANALYSIS OF 2D SOLAR RADIO FLARE PATTERN EVOLUTION

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Structural analysis of solar images is usually done qualitatively by using empirical procedures. Just in recent years an objective and more qualitative methods have been proposed. In this new framework multiresolution methods have been used to scientific visualization and characterization of physical processes on different scales. As shown in this paper, the 2D Fourier Spatial Decomposition (FSD) and Gradient Pattern Analysis (GPA) are methods which, working together, can be useful in monitoring solar active regions observed in radio frequencies. The technique combining FSD and GPA is called here Gradient Spectral Analysis (GSA). Here we analyze related flare solar radio emission (M and X classes) observed at 1.76cm from Nobeyama Radioheliograph (NoRH). In order to study the temporal evolution of the radio burst fine structures at different spatial scales, we perform GSA on synthesized radio images in intensity ($R+L$) and circular polarized ($R-L$) channels with 30 sec cadence. For image decomposition we use the method of 2D dimensional Fourier filtering of spatial harmonics. The decomposition was done in four spectral bands: 14-25, 25-50, 50-100 and 100-200 arc sec, which was limited by the spatial resolution of the telescope and the size of sources. We concentrate on the properties of continuous spatial spectra profiles of the radio images during the flares. It was found that sources with different sizes have different contribution in burst energy release. The role of flare knots with certain angular sizes in the formation of the pulse component is emphasized. We show that the gradient asymmetry spectrum, obtained from the gradient field of each decomposed image, captures the dynamics of irregular fluctuations during the solar burst evolution which is in part due to the presence of turbulent processes and plasma inhomogeneities in the radio source.

THE BEHAVIOUR OF THE 17 GHz SOLAR RADIUS AND LIMB BRIGHTENING IN THE SPOTLESS CYCLE XXIV

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The actual solar minimum has surprised all the solar community, since the spotless period is presently almost 2 years longer than the usual minima. In this work we studied the variation of the solar radius and the polar limb brightening at 17 GHz, comparing this minimum with the previous one. Daily maps obtained by the Nobeyama Radioheliograph (NoRH) from 1992 through 2010 were analyzed here. Whereas the variation of the solar radius at radio frequencies indicates the heating of the solar atmosphere due to solar activity, the limb brightening intensity depends on the organization of the polar magnetic field of the Sun such as a dipole and features formed around it. These features are more prominent during minima periods. The results show that: a) The mean solar radius at 17 GHz is 1 arcsec smaller in the actual minimum than in the 1996 minimum; b) While the mean limb brightening reaches 18% above the quiet Sun intensity in the 1996 minimum, the intensity in the present minimum is less than 14%. These results indicate that the solar atmosphere at this moment is colder than in the previous solar minimum and that there are less polar features due to the reduction of the polar magnetic field intensity. The question arising now is how will this unusual minimum reflect in the next solar maximum?

COMPUTATIONAL MODEL FOR SOLAR FLARE DYNAMICS AND EMISSION

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We present the stage of development of our computational model of solar flares. The model consists in the calculation of the non-thermal electron injection and dynamic evolution in a 3D flaring loop, along with the calculation of microwave and x-ray emissions. The electron evolution is obtained by numerically solving a time-dependent Fokker-Planck equation, considering the effects of Coulomb collisions and magnetic mirroring. The microwave emission is calculated by full gyrosynchrotron equations. The X-ray emission is calculated by a hybrid thin-thick target bremsstrahlung model. Free-free emission and absorption from the thermal background plasma is also included. The flaring loop can be represented by any three-dimensional structure, from a single semi-circular flux tube to arcades of magnetic field lines. Our model can be applied to study the electron dynamics and emission in different scenarios, spatial morphology of the emission, test injection characteristics, and also act as a tool to model observed events. Future development should include Ohmic losses due to reverse currents in electron dynamics, plasma response to beam heating (chromospheric evaporation), electron-electron bremsstrahlung to account for high-energy X-ray emission.