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22-year periodicity in the changes of the photospheric magnetic field distribution

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Photospheric magnetic fields are studied using synoptic maps for 1976 - 2003 (NSO, Kitt Peak). Synoptic maps were averaged over the period of nearly 3 solar cycles (cycles 21 - 23). The change of latitudinal distribution was considered for the following groups of magnetic fields: B = 0 - 5 G; B = 5 - 15 G; B = 15 - 50 G and B > 50 G. Magnetic fields in each of the groups have common features of latitudinal distribution, while for different field groups these features change significantly. Each of the groups is closely related to a certain manifestation of the solar activity.

Strong magnetic fields are connected with two manifestations of activity on the Sun: active regions (magnetic fields B>15 G) occupy sunspots zones and polar faculae (magnetic fields 50 G > B > 15 G) occupy latitudes around 65° - 75°. Fields from 5 to 15 G occupy the polar regions and are connected with polar coronal holes (solar global dipole). Fields with B<5 G occupy: a) equatorial region; b) latitudes 40° - 60° - connected with the solar global dipole.

Time-dependence of the magnetic flux for different groups of magnetic fields was studied as well as imbalance of positive and negative fluxes. When each of solar hemispheres is considered separately the imbalance displays 22-year periodicity for all field groups. For magnetic fields B<50 G (latitudes 40° - 90°) the imbalance changes its sign near the polar field reversal. The sign of the imbalance coincides with the sign of the polar magnetic field following the change of the solar global dipole sign. Imbalance of strong magnetic fields B>50 G (0° - 40°) changes its sign during solar minimum. The sign of the imbalance coincides with the sign of the leading sunspots which confirms the domination of the leading sunspot flux over the flux of the following ones.

For two hemispheres considered together imbalance of magnetic fluxes both of strong and weak magnetic fields changes with the 22-year solar cycle. The sign of the weak field imbalance (B<50 G) in the high latitude region (from +40° to +90° and from -40° to -90°) coincides with the sign of the polar field in the southern hemisphere. The sign of the strong field imbalance in the sunspot zone (B>50 G, from -40° to +40°) changes during the magnetic field reversal and always coincides with the sign of the polar magnetic field in the northern hemisphere. This asymmetry of positive and negative fluxes can be explained by the presence of the strong quadrupole component of the photospheric magnetic field.