# ON LOW-MODAL TORSIONAL WAVES IN THE DIFFERENTIAL ROTATION OF SOLAR MAGNETIC FIELDS

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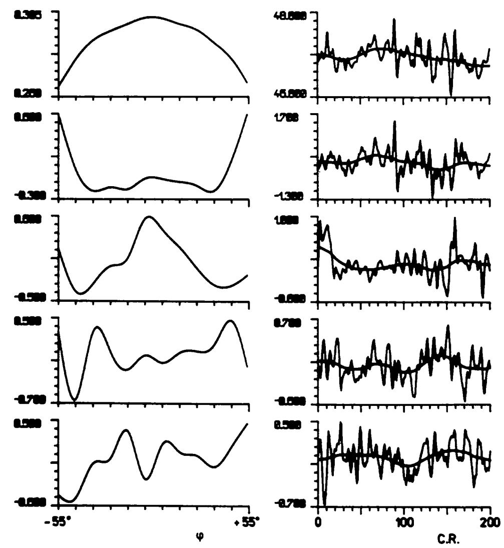
ABSTRACT. Using the method of principal components, applied to the matrix of dependence of the rotational velocity of solar background magnetic fields on time and heliographic latitude, it is proved that low modes of stationary torsional waves are most probably real phenomena, and that they cannot be the consequence of an unsuitable approximation of the latitudinal dependence of velocity in processing experimental material.

НИЗКОМОДАЛЬНЫЕ КРУТИЛЬНЫЕ ВОЛНЫ В ДИФФЕРЕНЦИАЛЬНОМ ВРАШЕНИИ СОЛНЕЧНЫХ МАГНИТНЫХ ПОЛЕЙ. На основе метода главных компонент примененного к матрицы зависимости скорости вращения солнечных фоновых магнитных полей от гелиографической широты и долготы показано, что низкие моды стоящих крутильных волн с самой высокой вероятностю реалны и что не могут возникать в следствии плохой аппроксимации широтной зависимости скорости при обработке экспериментального материала.

O NÍZKOMODÁLNÍCH TORZNÍCH VLNÁCH V DIFERENCIÁLNÍ ROTACI SLUNEČNÍCH MAGNETICKÝCH POLÍ. Na základě metody hlavních komponent použité na matici závislosti rotační rychlosti slunečních pozaďových magnetických polí na čase a heliografické šířce je ukázáno, že nízké mody stojatých torzních vln jsou jevy s největší pravděpodobností reálné a že nemohou být pouhým důsledkem nevhodné aproximace šířkové závislosti rychlosti při zpracování experimentálního materiálu.

LaBonte and Howard were the first to point out the existence of stationary torsional waves (k = 1/hemisphere) in 1982. By analysing the same data and with the aid of resolution into Gegenbauer's polynomials, Snodgrass and Howard (1985) later proved that other modes of stationary torsional waves with wave numbers k = 0 and 1/2 on a hemisphere can exist.




The weakness of the papers mentioned was the selection of the system of functions into which the latitudinal dependence of the rotational velocity was resolved. An unsuitable selection of these functions may complicate the interpretation of the results considerably, and it is also very important in studying non--stationary torsional waves with the wave number k = 2/hemisphere (Snodgrass, 1985). These difficulties can be avoided with the aid of the method of principal components (see, e.g., Vertlib et al., 1971, and the papers referenced herein) which simultaneously provides the "coefficients" of the resolution (i.e. the time functions) and the orthogonal functions into which the appropriate realizations are resolved. The resolution, obtained in this manner, is the best approximation of the actual data of all possible approximations of actual data of all the possible approximations obtained with the method of least squares.

If we apply this method to the matrix of rotational velocities obtained earlier and supplemented by quadratic interpolation (Hejna, 1985), which expresses the dependence of the rotational velocity on heliographic latitude (for $|\varphi| < 60^{\circ}$) and Carrington's rotation (for rotations 1490 to 1690), we obtain a system of eigenfuctions of which 5 with the highest eigenvalues (from top to bottom 2280.451, 0.263, 0.109, 0.666, 0.063), which express the magnitude of the contribution of the appropriate terms of the resolution, are shown in figure enclosed. The corresponding time functions are illustrated in the same order on the right side of this figure.

The first three pairs of functions clearly describe (with a view to the shape of the appropriate eigenfunctions) the modes of the stationary waves with wave numbers k = 0, 1/2, 1 per hemisphere, mentioned above. These time functions also indicate that these changes are in phase with the development of the 11-year solar activity cycle (cycle 20 begins at the zeroth and cycle 21 at the 150th Carrington rotation), and their pattern also qualitatively corresponds relatively well to the results of Snodgrass and Howard (1985); the shape of our eigenfunctions is quite similar to that of the Gegenbauer polynomials $T_0^1$, $T_2^1$ and $T_4^1$ they used.

It can, therefore, be stated that the torsional wave modes mentioned above can also be observed in the differential rotation of background magnetic fields, and that the abovementioned qualitative agreement of the results obtained with the results of other authors, obtained using different observation material, is evidence in favour of the real existence of the torsional waves of the type mentioned. It can also be said that, as a result of the similarity of the eigenfunctions found here with Gegenbauer's polynomials, we are justified in using these polynomials in describing the torsional waves as such.

## REFERENCES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