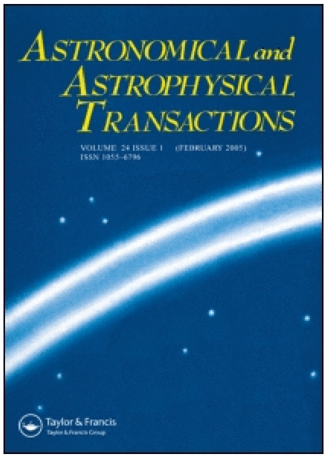

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Book Review

COSMIC WINDS AND THE HELIOSPHERE

Eds. J. R. Jokipii, C. P. Sonett, and M. S. Giampapa

Tuscon: The University of Arisona Press. 1997. pp. 971.

The University of Arizona Press (USA) publishing house issued in 1997, as one of the items of the longed–running Space Science Series, the book entitled *Cosmic Winds and the Heliosphere* (Eds. Jokipii, J. R., Sonett, C. P., Giampapa M. S.). 52 advanced specialists in corresponding areas were invited to compose a survey of a wide sample of problems.

The articles fill 971 pages of the book which also contains a short glossary with a brief description of a number of abbreviations and frequently used terms, such as Forbush-decrease, heliosphere, Eddington factor, etc., and detailed subject and author indexes are attached. The full size of the book amounts to 1013 pages. An ample bibliography (no less than 150–200 references) is attached to each paper. In its size and the number prominent co-authors the issue matches *Solar Interior and Atmosphere* (1416 pages; Eds. Cox, A. N., Livingston, W. C., Matthews, M. S.) issued by the same Publishers in 1991. Here, then, is a brief survey of the book in question.

The book opens with a long review article by E. N. Parker: "Mass ejection and brief of the solar wind concept". The author of the most detailed (for the time) theory of the solar wind and the most successful term "solar wind" (SW), now provides reasons in favour of the almost universal character of the concepts of hydrodynamic instability, thermal extension and plasma injection with respect to the atmospheres of objects of different types: galaxies (radiogalaxies, in particular), young (0, B) and non-stationary stars of a number of spectral classes, eruptive stars (including novae and supernovae), and of course, the Sun.

It is pointed out that plasma injection for objects of so varied a type must be fundamental with respect to evolution (e.g. the rotational momentum loss, etc.). But of course the best-studied phenomenon is the solar wind. Therefore, the major part of the reviews is concerned with the analysis of the wind sources in the Sun, the dynamical and structural features of the wind, including interactions with the interstellar medium and cosmic (stellar) wind. We mention once again that all the authors are prominent specialists, but we do not name them all (more than fifty) here. We shall just report briefly on the main contents of the papers. The papers (apart from the Introduction) are grouped into four sections: wind types, physics and generation of winds, physical phenomena, in the winds, and interaction of the winds with the surrounding medium.

The first section contains, quite naturally, a detailed description of theoretical and experimental work on solar wind (quiet and fast SW), actual models and difficulties met on the way to constructing an adequate picture of the phenomenon, observational data achieved through space- and ground-based observation being complete enough. It is pointed out that the long-time-scale (11- and 22-years-long) variations of solar activity produce considerable changes in the structure of the interplanetary plasma and the Earth's magnetosphere. Among other types of cosmic wind are the wind from cataclysmic variable (G, K, M- class) stars, and collimated outflow of matter from young stars (as deduced from the observations of H_2, Co and other line emissions in the IR spectral band). Cosmic wind from pulsating stars (Cepheids, long-period RR-Lyrae-type variables and others) is due not so much to thermal instability as to the stars' periodic compression and expansion and the formation of shock wave systems. The same section contains reviews dealing with particle acceleration, the interaction of the cosmic wind with the interstellar medium, the formation of "heliospheres" round stars of different types, wind in binary systems, and accretion. The section dedicated to wind generation, far from being solved problems, discusses solar corona supersonic expansion and, in that connection, mechanisms of corona heating are considered first of all. A particularly interesting problem is that of investigating the ejection of coronal mass (CME) which, though forming no more that $\sim$ 2–10% of the total of the quiet wind, is not, in all probability, related, unlike the plasma injection mechanism, to the thermal instability, but indicates MGD disturbances in long-time-scale magnetic formations of the Sun. Being similar in many respects to solar flares, the CME exceed them considerably in both space and time scales. Statistical analysis of more than 1000 CME cases made it possible to reveal a number of their characteristics: the mass ejected per one day; the CME spatial distribution during one solar cycle, and its coupling with the phenomena observed by the Johkoh Space Laboratory in the soft X-ray band. Being issued in 1997, the book, naturally, does not contain the latest data (including those achieved by SOHO on CME from not only the limb, but from the disk also).

The problem of cosmic wind with Alfven waves is analysed theoretically. MGD waves can be of considerable, or in some cases, of crucial importance for the Sun (in particular, for the fast solar wind and coronal holes). The review dealing with the physical properties of solar coronal holes that determine the fast solar wind looks incomplete after the new observational results of the SOHO Space Lab.

The section dedicated to physical processes in the cosmic wind is concerned, in the first place, with the properties of collisionless shock waves of a different type, including the CME phenomenon, and three-dimensional shock wave structures as reconsidered with the Ulysses Space Lab high-latitude observations taken into account. The problems of SW flux interaction at different distances from the Sun, including the "boundary interaction" of the SW with the stellar wind and galactic cosmic rays are analysed from the point of view of the observational data by Voyager I, Pioneer II, Helios and other Space Labs.

The data on high latitudes yielded by the Ulysses Space Lab adds to the SW ecliptic plane magnetic fields which form a typical Archimedes spiral. Attention is given, apart from the data on the interplanetary medium current sheet and its variations with the solar cycle, to the CME separate plasmoid magnetic field, near the ecliptic and high latitude field structure. Fast ($V > 750$–800 km s^{-1}) SW are connected not only with coronal holes, but with all of the high latitude ($|f_i| >$ 50–60°) zone as derived from the Ulysses data. Consequently, an open magnetic pattern of the global magnetic field of the Sun must exist at high latitudes. The stellar wind resulting from stochastic processes in RR Lyrae, delta Cephei, alpha Bootis, alpha Orionis stars, etc., may originate from radial pulsations, acoustic and non-linear waves, the loss of mass being of a sporadic, stochastic character. The solar and cosmic wind turbulence spectrum is predominantly of Kolmogorov type. The modelling of the SW structure and turbulence is related to the corona heat engine problem, as well as the SW composition (e.g. of He/H, Mg/O, etc. abundances) variations coupled with perturbations in the Sun. The evolution of the rotational angular momentum of late type stars due to injection of cosmic wind matter influences considerably the magnetic fields of the stars: the dynamo effects undergo evolutionary changes.

The last, rather extensive, section dealing with the cosmic (solar) wind and surrounding matter interaction gives room for the discussion of the following main problems:

(1) Typical parameters of the interstellar cloud in the vicinity of the Solar System as derived from UV spectra of the nearest stars. The matter density of 0.1 g cm^{-3}, at a temperature $T = 6800°$, turbulent velocity ~ 1.7 km s^{-1}, and the modulus of the magnetic field $B > 3.5$ mG are determined.

(2) Detection of shock waves propagating through the interstellar medium. The wave velocity at a temperature of $T \sim 10^4$ K is $V \sim 25$ km s^{-1}.

(3) Radioemission from the outer heliosphere at frequencies of 2–3 kHz. The measurements were performed by Voyager in 1992.

(4) Transportation and acceleration of SW high energy particles, modulation of the galactic cosmic ray (CR) flux, acceleration of particles at the collisionless shock wave front.

(5) CR effects on interstellar gas and wind dynamics, and determination of the hydromagnetic diffusion tensor independently of the particle energies made it possible to derive the main equations for the stellar wind and galactic CR interaction and particle acceleration by the shock waves.

(6) The shock waves in the CW from supernovae and presupernovae with proton energy rating up to $> 3 \times 10^9$ Gev, the "hot spots" in radiogalaxies, are discussed briefly.

(7) The problem of CW interaction with comet tails yielding information about the direction of motion and parameters of CW out of the ecliptic plane is considered separately.

So, such is the list of problems discussed in the book. The book is a sort of encyclopedia: it brings together and subjects to rather detailed discussion seemingly different problems related to the cosmic and solar wind. Large lists of references on every problem considered in the book permit thorough investigations. Newer SOHO data on the solar wind may be extracted from *Solar Physics* (1997) **175**, 1–2. The book may be of great help for scientists working in the area (heliophysicists, astrophysicists, cosmophysicists and geophysicists), and university post- and undergraduates, specializing in corresponding fields.

E. I. Mogilevsky