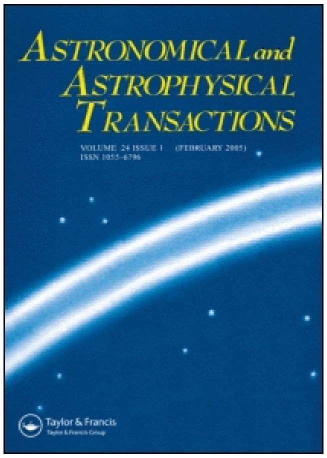

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SHKLOVSKY'S IDEAS AND THE RECENT STUDY OF THE SOLAR CORONA

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Shklovsky's contribution to the study of the solar corona considered in the light of recent findings coronal physics.

KEY WORDS Sun, solar corona

1 INTRODUCTION

Shklovsky's fundamental contribution to the study of the solar corona is well known. His theory of the coronal plasma ionization (a doctoral thesis) created the basis for recent coronal physics. In his two monographs The Solar Corona (1951) and The physics of the Solar Corona (1962) – Shklovsky summarized all the observational data and principal knowledge on the solar corona available in 1951 and 1962 respective, including his own findings. Shklovsky's contribution to the solar physics is, however, much wider than just coronal ionization theory. In both books there are a number of passages containing the author's original analysis of different coronal problems, as well as new ideas scattered over the various sections of the books. Indeed the second book was a summary of his study of the solar corona.

The rapid progress in the technique of solar observation starting in the mid 1960s essentially improved the observational base for coronal research. During the last 40 years the spectral range of the recorded solar irradiance was extended significantly from radio to X-ray frequencies and very high spatial resolution (better than 1 arc sec) of the coronal spectra and images was reached. The SOHO and YOHKOH missions provided daily white-light and EUV monochromatic limb and disk coronal pictures of high spatial resolution. Due to the new technique of solar observation, the last 30 years have been especially successful in the study of coronal morphology and phenomenology in connection with the solar magnetic field structure and evolution. *The main finding in coronal physics in the last 50 years is the concept of the solar corona phenomenon as a composition of the hot plasma structures created* *and confined near the Sun by closed solar magnetic fields of different types, that can be estimated as one of the most important results in solar physics as a whole.*

However, this is not a new idea. Shklovshy came to the same understanding of the nature of the solar corona approximately 40 years ago, through the analysis of the rather poor observations of those distant times. Shklovsky's scientific method was always marked by a deep physical approach combined with deduction and acute intuition that allowed him to penetrate the problem more deeply than others. His studies always led to a clear physical image of the subject under investigation. Unfortunately his forward findings on the structure of the solar corona were not generalized as a coronal concept but remained as odd text fragments of both monographs. The aim of this brief commentary is to show Shklovsky's prime position in research into the nature of the solar corona by putting together some of his results.

2 SHKLOVSKY'S PREDICTIONS

First of all one must realize the character and quality of the observations used by Shklovsky in solar corona research. These were ground-based white-light corona and spectral observations of low spatial resolution, performed under expeditionary conditions. At those distant times coronal filtergrams were a rarity. Solar radio astronomy was taking its first steps. Non-eclipse coronal observations arranged for the activity patrol cannot be used for the study of coronal physics because of their low spatial and spectral resolution. Spacecraft experiments provided mainly EUV spectra of too poor spectral and spatial resolution. Only eclipse large-scale white-light corona images taken with standard coronagraphs were of sufficiently good quality to study the coronal structure. These old observations, unlike recent ones, were not so obvious and required deep analysis.

Shklovsky was the first to introduce the solar magnetic fields into the consideration of the solar corona, still in 1951 (Shklovsky, 1951a). Reading both his monographs, we can trace how step by step he approached the understanding of the solar corona as a magnetoplasmic formation.

After the analysis of the results of Van-de-Hulst's photometry of the polar corona he concluded that the polar corona rays could not be formed by plasma flows but had to be of another origin (Shklovsky, 1951b). He pointed out (Shklovsky, 1951a, b) that various white-light corona structures including streamers and other features are undoubtedly connected either with the general magnetic field of the Sun or with magnetic fields of the active regions.

Shklovsky explained the coexistence in the corona of plasma features with different temperature regimes ("red" and "green" coronal regions in the terms of the time) as well as the existence of the coronal structures by the effect of solar magnetic fields which impede the diffusion processes perpendicular to the magnetic field strength lines. He showed by calculation that without magnetic fields all the plasma inhomogeneity will be smoothed over a period from several hours to a few minutes by fast thermal motions of coronal ions (Shklovsky, 1951c). At the same time he made the first estimations of the lower boundary of the coronal magnetic field strength sufficient for the entire control of the coronal plasma motion: 10^{-7}–10^{-6} G (Shklovsky, 1951c).

All these conclusions were made at the epoch when the magnetic fields were practically not considered in solar physics.

Eleven years afterwards, in the book *The Physics of the Solar Corona*, Shklovsky considered the problem of the coronal magnetic fields again. He poined out that solar magnetic fields, rooted deeply in the photosphere, create a kind of hard skeleton for the corona surrounded by hot plasma. He predicted the rigid rotation of the lower and the middle corona with the Sun that has been confirmed by later observations. On the basis of this effect Shklovsky made a new estimation of the coronal magnetic field strength and infers a value of ~ 1 G (Shklovsky, 1962a).

Discussing the problem of the thermal isolation of cold prominences surrounded by the hot coronal plasma, Shklovsky came to the conclusion that only magnetic fields can provide such isolation effects (Shklovsky, 1962b).

In the section devoted to coronal structures (Shklovsky, 1962c) the coronal plasma inhomogeneity is treated from the point of view of the influence of coronal magnetic fields. The coronal structures are considered as magnetic traps similar to *TOKAMAK.*

3 CONCLUSION

So, beyond all shadow of doubt, one of the most important findings in recent solar physics – the solar corona concept as a hot plasma confined by magnetic traps was considered by I. S. Shklovsky a long time ago, between 1950 and 1962. Unfortunately his new ideas on the magnetoplasma nature of the solar corona were too progressive for that remote time and therefore were not recognized until now. For this reason coronal research often reached a dead end.

Shklovsky's ideas in solar corona physics are bright samples of classical astrophysics and remain highly topical.

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