

Preface

The first steps of research of Solar Radio Bursts are described in the famous monographs by Zheleznyakov (1964) and Kundu (1965). The rapid progress of the Solar Radio Astronomy was regarded in the excellent book by Kruger (1979). This survey covers successive development of radioheliographic observations, the detection of spectral fine structure and various kinds of extraterrestrial observations. A theoretical description of radio emission mechanisms was published by Zheleznyakov (1998): “*Radiation in Astrophysical Plasmas*”. The solar radio physics has grown to be an extended field, making it rather impossible for a single person to review many topics.

The recent review by Pick and Vilmer (2008), A&A Rev. 16, 1–153: “*Sixty-five years of solar radioastronomy*” is a general historical description of the solar radio emission in a wide aspect of its relation with X-ray emission, CME, interplanetary shock waves, etc. This is a very useful review and may be unique, after the monograph by Kruger (1979).

All these editions do not almost contain however any information about the fine structure of radio bursts. The study of the fine structure of the solar radio emission is a key to understanding the plasma processes in the solar corona. It remains a reliable means for both diagnosing the solar corona and verifying the results of laboratory plasma experiments on the wave–wave and wave–particle interactions. The high time and frequency resolution data have improved our studies of similar fine structures in stellar flares.

Already the first spectral observations of large type IV (and II+IV) bursts revealed the rich variety of the fine structure of the radio emission in the form of wide-band pulsations in emission and absorption with different periods, rapid bursts (spikes) and narrow-band patches. Modulation of the continuum emission in the form of narrow stripes in emission and absorption (zebra pattern (ZP) and fiber bursts (FB)) appeared to be the most intriguing elements of the fine structure. Pulsations and spikes usually accompany ZP and FB in the dynamical radio spectra. After the short review of some elements of fine structures by Fomichev and Chertok (1976) and the short theoretical description of the emission mechanisms by Kuijpers (1980), only the atlas by Slotje (1981) (with a small number of copies) gives exhaustive experimental results about ZP and FB. If pulsations and

spikes obtained sufficiently adequate interpretation, then for ZP and FB during several decades more than ten different mechanisms were developed.

During last almost two decades with the space missions, such as soft X-ray observations with Yohkoh, extreme-ultraviolet (EUV) observations with SOHO and TRACE and now RHESSI and Hinode, we have rich information about the flare evolution in different spectral ranges. And now, it should be studied how they could help us to understand the processes of formation of different fine structures. The exhaustive description of Physics of the solar corona in Aschwanden (2004) represents a comprehensive source for this purpose.

The plan for this book resulted from a desire to have a concise up-to-date survey of the fine structure of solar radio bursts. This volume has grown out of more than 40-year-old experience of the author in the study of spectral fine structure.

In this book we shall show the entire diversity of experimental data with the development of the observational techniques, with the goal to confirm or disprove theoretical models. The author does not pretend however to give an exhaustive survey of all published works in the field of fine structure. This cannot be presented in one volume. The author tried rather to present materials not illuminated earlier in any reviews. Moreover, the exposition of the materials is most likely an author's view, without pretending to have achieved a universal description "of all and entire". The reader will notice that many of the figures are taken from the author's own work based on observations of fine structure in the meter range conducted over more than 40 years (Markeev and Chernov 1970). To our knowledge no other observatory in the world possesses similar high-resolution data. Therefore, the author apologizes in advance before the colleagues who might have the impression that their work did not receive proper citation.

Chapter 2 is devoted to radio pulsations. After several excellent reviews (Slottje 1981; Roberts et al. 1984; Aschwanden 1987, 2004), here, the preference is given to the description of millisecond pulsations, which have not yet been described properly.

Perhaps, the largest number of works was devoted to the fastest bursts, the spikes. In Chap. 3, a view of the author on number of problems is given. And again, the preference is there given to the description of the models of millisecond spikes, which is continued in Chap. 4, since they were discovered as the superfine structure of the zebra pattern (ZP).

Chapter 4, the largest chapter, gives a sufficiently complete description of the historical development of both the experimental data and theoretical models of ZP and FB.

Chapter 5 is devoted to recent observations with the highest resolution (~ 1 ms, and partially much less), when several new details of the fine structure were discovered. The description of new mechanisms of the ZP was continued, a special attention was given to works on the improvement of model at double plasma resonance (DPR), since in the past 3–4 years more than 10 articles were published on this theme.

Since this book deals with the observation and theoretical models of the fine structure of solar radio bursts, it covers a wide field of Solar Radio Physics and will be useful to graduate students and researchers.

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