Astrophys Space Sci (2013) 346:301–306
DOI 10.1007/s10509-013-1455-9

ORIGINAL ARTICLE

Deterministic behaviour in the dynamics of solar metric radio bursts with intermediate drifting patterns

Adolfo L. Méndez Berhondo · Ana K. Díaz Rodríguez · P. Zlobec · Lupe Cuendias Pérez

Received: 28 January 2013 / Accepted: 10 April 2013 / Published online: 25 April 2013

Abstract The dynamic characteristics of solar metric radio bursts with intermediate drifting patterns (fiber bursts) as they evolve at fixed frequency are examined. The data were recorded using the radio polarimeter of the Trieste Astronomical Observatory. The aim is to determine if the underlying process can be described as a deterministic chaos. Correlation dimensions and Hurst exponent are estimated showing deterministic chaotic system of low dimension.

Keywords Intermediate drift bursts · Radio emission · Non-linearity · Deterministic chaos

1 Introduction

Solar bursts observed at radio frequencies (from metric to microwave wavelenghts) sometimes show pulsating temporal structures that involve a great variety of phenomena, including sinusoidal oscillations, quasi-periodic patterns and repetitive outlines of fine structures such as train of intermediate drift bursts (equally named fibers bursts), zebras, spikes, and also Type I bursts. The great diversity of such phenomena involves different explanations and theoretical modelling. According to the assumed driver mechanism, models of pulsation had been grouped as MHD oscillations (i.e. plasma oscillations), cyclic self-organizing systems (i.e. wave-wave or wave-particle interactions) or modulation of periodic particles injection or also magnetic reconnection (see Aschwanden 1987 for review).

Fiber bursts have been recognized as particular fine structures observed in some Type IV bursts since Young et al. (1961). Their drift is intermediate with respect to the drift of Type III and Type II bursts. Nevertheless, Slottje (1972, 1981) reported fiber bursts with higher drift than Type III bursts and lower drift that is typical for Type II bursts. Fiber bursts have been studied mostly from dynamic spectra where they appear as stripes in emission and absorption with respect to the underlying continuum of Type IV radio burst. In Chernov (2006) a comprehensive review of fiber bursts properties can be found.

According to our knowledge no paper deals with fibers recorded at fixed frequency. We study such bursts recorded at 327 MHz during the April 17, 2002 Type IV solar radio burst. In the time interval we selected (lasting 80 s) a well-defined cluster of fiber bursts is present. Some temporal characteristics of the dynamic trend are examined in order to inquire if the underlying process can be described as deterministic chaos.

2 Data

We use the data recorded by the radiopolarimeter of the Trieste Solar Radio System (INAF, Trieste Astronomical Observatory) at 327 MHz from 09:42:51 to 09:44:11 UT when a well-defined cluster of fiber bursts (strongly polarized in the left-handed sense) is present; the time resolution is 10 ms. Figure 1 shows the dynamic spectrum recorded at the Astrophysical Institute Potsdam in the range 260–390 MHz and the time profile of the analyzed cluster of fiber bursts at 327 MHz. This cluster was recorded near the end of the decaying continuum of the principal maximum of the Type IV burst.

A.L.M. Berhondo (✉) · A.K.D. Rodríguez · L.C. Pérez
Astronomy Department, Institute of Geophysics and Astronomy, Calle 212 No. 2906, 11600, Havana, Cuba
e-mail: ado@iga.cu

P. Zlobec
Trieste Astronomical Observatory, INAF, via G.B. Tiepolo 11, 34143, Trieste, Italy