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Identification of Physical Components in Pulsar Emission

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Abstract. We have used power spectra analysis on high frequency (1.4 GHz) data, obtained with the Effelsberg 100m radio-telescope in order to investigate the emission characteristics of pulsars. This analysis has not only revealed the prominent periodicities of the fluctuating components, but has also proven a powerful tool for identifying weak and often unresolved components and their longitudinal location within the integrated pulsar profile. Furthermore, close examination of the properties of the fluctuating components indicates physical connections between them, giving new insight to the structure of the emitting region.

1. Introduction

In the integrated pulsar profiles distinct *components* can be identified (Seiradakis et al. 1995). They are thought to represent coherent physical regions in the magnetosphere. Therefore their properties are of extreme importance for understanding the emission mechanism of pulsars. These components are often blended and their shape and longitudinal location within the pulsar profile is difficult to be established. Although there are no rigorous theoretical arguments, usually they are fitted with Gaussian curves, the parameters of which are easily obtained. Experience has shown that pulsar profiles can indeed be reconstructed by a sum of individual Gaussian components. This method usually involves some arbitrary assumptions which can be minimized by reducing the number of degrees of freedom of the gauss–fitting procedure (Kramer 1994). The gauss–fitted components of two pulsars are shown in Fig. 1.

2. Analysis: Identification of Physical Components

It is expected that the fluctuating properties of a coherent region in the magnetosphere will be unique and, therefore, the components of pulsar integrated profiles should exhibit unique fluctuation spectra. Long sequences of single pulses from 17 pulsars have been investigated using the well established method of *power spectra*. The shortest sequence used consisted of 256 pulses, the longest of 2048. The time resolution of PSR B0950+08 and PSR B1822–09 could be improved. In this work we concentrate on the spectra of individual longitudinal intervals with a fairly good time and frequency resolution. It becomes clear, that inten-

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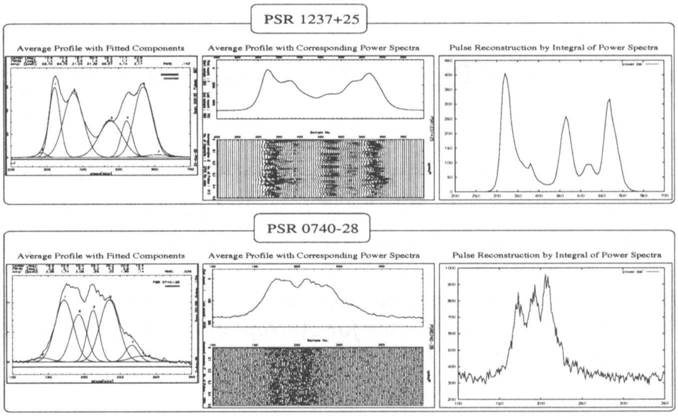

Figure 1. Physical components in integrated pulsar profiles are easily detected using power spectra

sity fluctuations of the emission can be well investigated. Also the fluctuating power emitted (reconstructed pulse shape, Fig. 1) gives a clear representation of the physical components of the pulse, originating from coherent regions in the magnetosphere.

3. Results and discussion

The components detected by the *fluctuation-spectra method* are usually sharp and well defined (Fig. 1). Their longitudinal location can be accurately determined. (Examples: PSR B0740–28, PSR B1237+25, PSR B2020+28)

In a few cases periodic fluctuations contribute significantly to the fluctuating power. However, in others, non periodic, random fluctuations dominate the power spectra for a large frequency range. (Examples: PSR B0809+74, PSR B1822-09, PSR B1919+21)

Core components often fluctuate vigorously. We found no periodic fluctuations in the core components, but in several cases the power in the core fluctuations, exceeded greatly the power in the cone fluctuations. (Examples: PSR B0329+54, PSR B1237+25)

Fluctuating components do not always correspond to a gauss-fitted counterpart. This is an interesting result, indicating that the mechanism producing the fluctuations is independent of the mechanism shaping the component. It may, for example, be due to propagation effects or other transportation effects. (Examples: PSR B0355+54, PSR B2021+51)

References

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