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ORIGINAL ARTICLE

Noise statistics in a fast digital radio receiver: the Bedlam backend for the Parkes radio telescope

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Abstract The digital record of the voltage in a radio telescope receiver, after frequency conversion and sampling at a finite rate, is not a perfect representation of the original analog signal. To detect and characterise a transient event with a duration comparable to the inverse bandwidth it is necessary to compensate for these effects, altering the statistical properties of the signal and making it difficult to determine the significance of a potential detection. We present an analysis of these modified statistics and demonstrate them with experimental results from Bedlam, a new digital backend for the Parkes radio telescope.

Keywords Coherent pulse detection · Gaussian noise statistics · Digital radio receivers · ADC non-linearity

1 Introduction

Typical radio astronomy applications are not sensitive to transitory extreme fluctuations in the signal voltage from the telescope receiver. For example, when measuring the spectral intensity of a static astronomical object, mere single-bit sampling of the voltage achieves a minimum of 64 % of the signal-to-noise ratio for the ideal many-bit case, even though the ability to measure the magnitude of a single sample is entirely lost [13, Sec. III]. However, in applications in which a single high-magnitude sample is observationally meaningful—implying a signal with time structure on

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