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Observational effects of banded repeating FRBs

banded 重复FRB的观测效应

<https://arxiv.org/abs/2108.04474>

type:observation-FRB

comment:FRB的banded emission会导致在观测波段的不完整性,使探测到的FRB样本出现偏差

► details

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Comments: 9 pages, 5 figures, submitted to ApJL

Recent observations have shown that repeating Fast Radio Bursts (FRBs) exhibit band-limited emission, whose frequency-dependent amplitude can be modeled using a Gaussian function. In this analysis, we show that banded emission of FRBs can lead to incompleteness across the observing band. This biases the detected sample of bursts and can explain the various shapes of cumulative energy distributions seen for repeating FRBs. We assume a Gaussian shape of the burst spectra and used simulations to demonstrate the above bias using an FRB 121102-like example. We recovered energy distributions that showed a break in power-law and flattening of power-law at low energies based on the fluence threshold of the observations. We provide recommendations for single-pulse searches and analysis of repeating FRBs to account for this incompleteness. Primarily, we recommend that burst spectra should be modeled to estimate the intrinsic fluence and bandwidth of the burst robustly. Also, bursts that lie mainly within the observing band should be used for analyses of energy distributions. We show that the bimodality reported in the distribution of energies of FRB 121102 by Li et al. (2021) disappears when burst bandwidth, instead of the center frequency of the observation, is used to estimate energy. Sub-banded searches will also aid in detecting band-limited bursts. All the analysis scripts used in this work are available in a Github repository).

- 最近的观测显示重复的FRB展现了band-limited(带限)的辐射, 这些FRB的幅度-频率关系可以用高斯函数来拟合.
- 文章指出, FRB的banded emission会导致在观测波段的不完整性(incompleteness).
- 这使探测到的FRB样本出现偏差, 解释了在重复FRB中观察到的多样的累积能量分布
- 作者假设爆的能谱是高斯的, 通过模拟, 使用类 FR121102的例子证明了上述偏差.
- 作者重现了具有转折幂律以及在低频端幂律由于观测阈值而变平的特征的能量分布.
- 作者给出了单脉冲搜寻和重复FRB分析的建议(recommendations)来解释这种不完整性:
 - 首先, 作者建议应该对爆的能谱进行模型拟合(而不是依靠信噪比)来可靠地估计内秉的通量和爆的带宽.
 - 此外, 应该用主要位于观测波段内(而不是位于观测波段边缘)的爆来分析能量分布.

- 作者展示了如果使用爆的带宽, 而非观测的中心频率, 来估算能量的话, Li 2021报告的FRB121102的能量分布的双峰性就不存在了.
 - 子带(subbanded)搜寻也将有助于搜寻带限爆.
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Q&A:

- band-limited emission?
 - 辐射局限于某一波段
- incompleteness?

Primarily, the banded nature of burst spectra leads to a non-uniform completeness limit across the observing band. This is because many bursts that lie primarily outside the observing band will not be detected.

- bias?

We assumed the spectra to have a Gaussian shape and simulated bursts from an FRB 121102-like source. We then showed that **the energy distribution of the detected bursts looks substantially different from the intrinsic distribution** and might show peculiar shapes.