MODELING THE REDSHIFT AND ENERGY DISTRIBUTION OF FAST RADIO BURSTS

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主要内容

□ FRBs

¨ 数据

□ FRB模型限制

- 恒星相关模型
- 超导宇宙弦模型

□ 总结

1. Fast Radio Bursts

Thornton et al. 2013

2.2 样本光度 the isotropic energy releases of the FRBs by the F
The FRBs by the ²(1 + *z*)⌫*S*⌫*t*obs*k*(*z*)*,* (2)

 10^{38} 0.2 0.4 0.6 0.8 1.0 1.2 1.4

Energy (erg)

Redshift

 $E = 4\pi d_c(z)^2(1+z)\Delta\nu S_\nu\Delta t_{\text{obs}}k(z)$ **○ 箱射谐**形 of the Parkes survey, *S*⌫ and *t*obs are the average flux density and the pulse width of the FRBs. The correction factor k converts the observation factor k converts the observation k common emitting k common emitting k converts the observation of k common emitting k contains the observation of k common emit Γ ₄ is the comoving distance, Γ of the Parkes survey, *S*⌫ and *t*obs are the average flux density and the pulse width of the FRBs. The correction factor factor of the observation factor of the observation of the observation of the observation of
The observation of the observatio frequency range of $S_{\nu} \propto \nu^{-\beta}$ $\begin{bmatrix}\n\hat{a} \\
\hat{b} \\
\hat{c}\n\end{bmatrix}$ 10⁴⁰ ¹ ⌫*^a* $k(z) = (1+z)^{\beta-1}(\nu_b^{1-\beta} - \nu_a^{1-\beta})$ we plot the *z* $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\$ $d = d(\omega)2(1 + \omega)$ of the Parkes survey, *S*⌫ and *t*obs are the average flux density and the pulse width of the FRBs. The correction factor factor \mathcal{A} converts the observation of \mathcal{A} from a state of $S_{\nu} \propto \nu^{\nu}$ $k(z) = (1+z)^{p-1}(\nu_b^{1-p} - \nu_a^{1-p})/(\nu_2^{1-p} - \nu_1^{1-p})$ we plot the FRB distribution in the *z E* plane in Figure 1, where the *k*correction is not included. ü辐射谱形 10^{39} 1040 10^{41} 10^{42}

E = 4⇡*dc*(*z*)

²(1 + *^z*)⌫*S*⌫*t*obs*k*(*z*)*,* (2)

frequency 1.2 and 0.4 and 0.6 and 1.8 and 1.2 and 1.4 and *Redshift* **Redshift**

2.3 探测阈值 Due to the system noise *S* / *t t* 1*/*2 obs . Thus, it is necessary to clarify the redshift-dependence of pulse width for determining the threshold. **the second interview of the observation of the observation**

$$
E_{\rm th}(z) = 4\pi d_c(z)^2 (1+z) \Delta \nu n_{\rm min} \Delta S \Delta t_{\rm obs} k(z)
$$

$$
\Delta t_{\rm obs}(z) = \sqrt{\Delta t_{\rm burst}^2 (1+z)^2 + \Delta t_{\rm DM}^2 + \Delta t_{\rm scat}^2} \quad \text{in } \mathbb{R}^2
$$

For an FRB with an intrinsic pulse width *t*burst located at redshift *z*, its observed duration is influenced

3. FRB模型限制 tain *k*correction is not taken into account. As shown, such a threshold is well consistent with the data

FRB numbers for redshift range *< z* can be changed to

 $-$ FDD $h\bar{h}$ $\pm i$ $\sqrt{2}$ By considering of the telescope selection by the energy threshold of *E*th, the calculation of accumulated 7叮巴*叭*
并合、超是 红导军国弦、 □FRB的起源:恒星爆发后的新生中子星、双中子 (*E*)*R*˙(*z*⁰ 1 + *^z*⁰ *,* (9) 星并合、超导宇宙弦、小行星撞击。。。

FRB numbers for redshift range *< z* can be changed to where *E*max = 10⁴² erg is taken and an energy function (*E*) is introduced to describe the intrinsic □ 通过对FRB红移分布和光度分布对模型进行限制

accumulated number for energy range of the state of the sta
The state of the s *N*obs *<E* ⁼ *^T ^A* ■ W 辐射谱形 max(*z*), where the value of *z*th is solved from the equation of 1*.*9), where the equation \mathcal{L} is solved from the value of 1*.*9), where \mathcal{L} is so \mathcal{L} is so \mathcal{L} is so \mathcal{L} is the value of 1*.*9), ü辐射谱形 ü本征爆发率 ü光度函数

3 .1例如:恒星相关模型 assume that the burst rate of FRBs at redshift $\mathbb{E}[\mathcal{A} \mapsto \mathcal{A}[\mathcal{A}]$ at the same redshift. Nevertheless, for a general consideration, the proportion, the proportional coefficient
The proportion of proportion, the proportional coefficient between the proportion of proportional coefficient coupsertaster in the constant between the proportion \mathcal{R} and \mathcal{R} in \mathcal{R} i $F(x, y) = F(x, y)$ is the normalized cumulative distributions of redshifts and energies of *FRBs* for a = 5 (*dashed line*) and energies of FRBs for a = 5 (*dashed lines*) and energies of FRBs for a = 5 (*dashed lines*) and en <u>and a spectral index β = −</u>2. The value of γ is taken according to Eq. (11). The value of γ is taken according to Eq. (11). The value of γ is taken according to Eq. (11). The value of γ is taken according to Eq. (11). T 0.0 0.5 1.0 1.5 0.0 0.2 $\frac{1}{2}$ 40.5 $\frac{1}{2}$ $\overline{1}$ \Box \overline{a} and calculation of \overline{a} \blacksquare

$$
\begin{array}{ll}\n\sqrt{\mathcal{A}} \text{ if } \frac{1}{2} \text{ if } \frac{1}{2}
$$

 $\overline{\mathcal{L}}$ **√辐射谱形** \checkmark 辐 针谱形 \mathbf{r}'

two rates is assumed to evolve with redshift as a power-law function as a pow

$$
S_{\nu} \propto \nu^{-\beta}
$$

v
◆ 光度函数

$$
\checkmark \nexists \tilde{\mathcal{F}} \mathbb{E} \mathbb{E} \mathbb{E}
$$
\n
$$
\Phi(E) \propto E^{-\gamma}
$$

! ^z

! ^Emax

Normalized Accumulated Number

ical studies of gamma-ray bursts (e.g., Cao et al. 2011; Yu et al. 2012). The obtained values of the power-law

)

3.2 例如: 超导宇宙弦模型 超导军宙较模型 WEV J 田公次王 1: 超导宇宙弦模 \mathcal{F} γ \sim 0.4 GHz is the frequency bandwidth of the frequency bandwidth of the frequency bandwidth of the frequency of *E*iso ⇠ 4⇡⌫ \mathbf{b} detected and an isotropically-equivalent energy would be \mathbf{b} - 十 中 12 $n \in \mathbb{N}$ the the case of \mathbb{N} of \mathbb{N} of \mathbb{N} as \mathbb{N} 2012a, 1920
2012a, 1920

1

0

the energy released into unit frequency band and unit solid

*E*iso ⇠ 4⇡⌫

ber density of the loops at radiation time *t* can be expressed as

$$
d\dot{N}(z, E_{\text{iso}}) = \frac{\theta^2}{4P_{\text{osc}}} \frac{dn(z)}{dL} \frac{dL}{dE_{\text{iso}}} dE_{\text{iso}} dV_p(z)
$$
\n
$$
\frac{dn(z)}{dt_z} \sim \left(1 + \sqrt{\frac{ct_{eq}}{L_i}} \frac{1}{L_i^2(ct)^2} \sim \sqrt{\frac{ct_{eq}}{L_i}} \frac{1}{L_i^2(ct)^2} \propto t^{-9/2} \right)
$$
\n
$$
\frac{d^2E}{dv d\Omega} \sim \frac{k_{\text{em}} I^2 L^2}{c^3} \longrightarrow E_{\text{iso}} \sim 4\pi \nu \frac{d^2E}{dv d\Omega} \qquad L \sim \left(\frac{c^3 E_{\text{iso}}}{4\pi k_{\text{em}} I^2 v_0 f_z}\right)^{1/2}
$$
\n
$$
L \sim \left(\frac{\hbar^2 c^3 E_{\text{iso}}}{4\pi e^4 k_{\text{em}} B_0^2 v_0 f_z^5}\right)^{1/4}
$$
\n
$$
d\dot{N}
$$

where the relationship $\mathcal{L}^{\mathcal{L}}$ is $\mathcal{L}^{\mathcal{L}}$ in $\mathcal{L}^{\mathcal{L}}$ in $\mathcal{L}^{\mathcal{L}}$

angle can be estimated to (Cai et al. 2012) α

dn/*dLi* ⇠ ^h

, (a) \sim

*L*⁵/² *ⁱ* (*ct*) i¹

energy range of *E*iso and *E*iso + *dE*iso can be calculated by

where $\frac{1}{2}$ $\frac{1}{$

The event rate density of SCS bursts at redshift *z* within the

dominated era, respectively (Cai et al. 2012a,b). Since FRBs were only observed at relatively small redshifts, the corresponding α

For a SCS loop that formed at cosmological time *ti* with an

From Eqs. (13), we can express the length of SCS loops

that produced $\mathcal{F}_{\mathcal{B}}$ by observational $\mathcal{F}_{\mathcal{B}}$ as associated by observational $\mathcal{F}_{\mathcal{B}}$

loop, *t* ⇡ (1/*H*0)*f*

3/2

1/³ is used. The

^z is the cosmological time at which the

observed SCS burst is radiated, *H*⁰ is the Hubble constant, and

$$
\frac{d\dot{N}}{dE_{\text{iso}}dV_{\text{p}}(z)} \sim 1.1 \times 10^{-36} I_{16}^{5/3} \mu_{17}^{-3/2} v_{0,9}^{1/6}
$$
\n
$$
\mathcal{L}_{\text{iso},40}^{-11/6} f_{\text{z}}^{65/12} \text{erg}^{-1} \text{Gpc}^{-3} \text{yr}^{-1}
$$
\n
$$
\sqrt{\frac{1}{16}} \frac{\sqrt{\frac{1}{16}} \sqrt{\frac{1}{16}}}{\sqrt{\frac{1}{16}} \sqrt{\frac{1}{16}}}
$$

4.总结

通过对FRB红移分布和光度分布对模型进行限制

- ^Ø 观测数据的积累和更新 ^Ø 散射效应的红移依赖
- ^Ø 辐射谱形对流量的k改正
- ^Ø 本征爆发率
- ^Ø 光度函数积分