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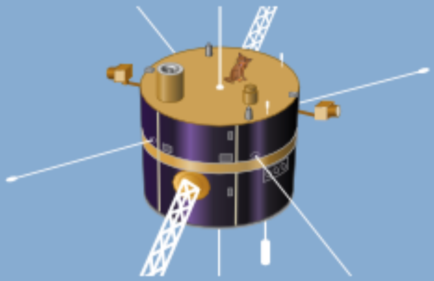
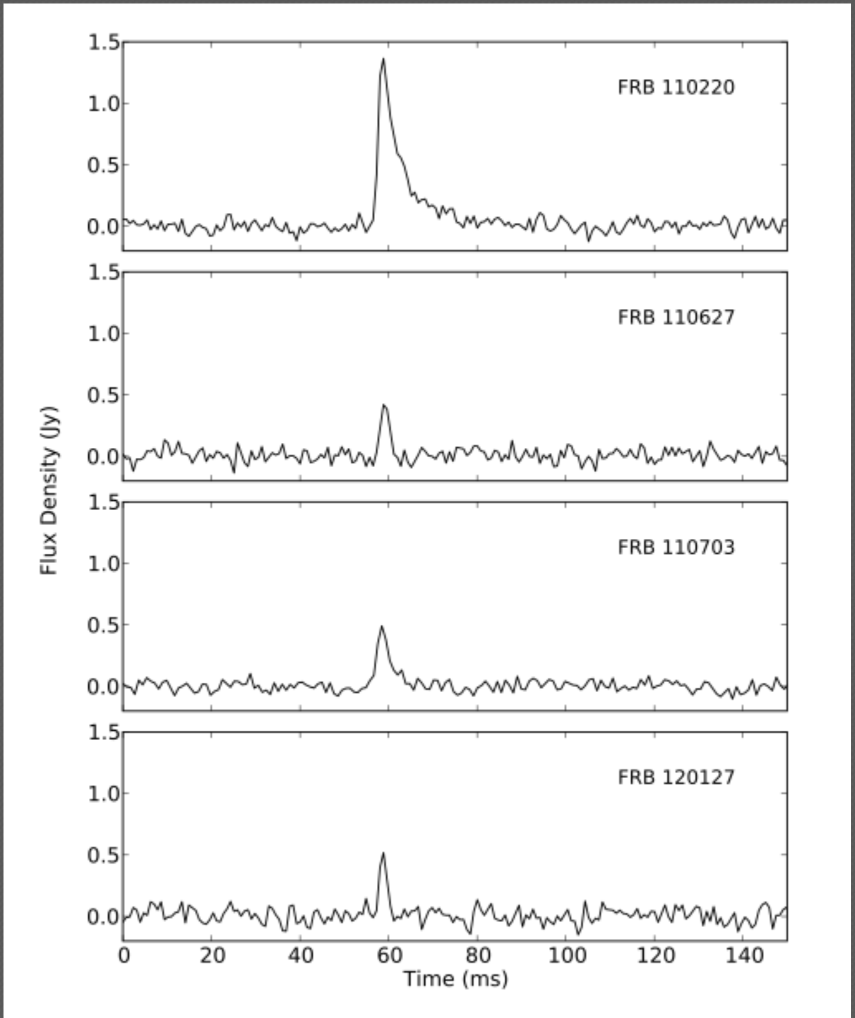
Scenario Machine: Fast Radio Bursts, short GRB and LIGO silence



Ioffe Workshop on GRBs and other transient sources:
20 Years of Konus-Wind Experiment

22–26 September 2014, St.Petersburg, Russia

FAST RADIO BURSTS



64-m Parkes radio telescope (Australia)
High Time Resolution Universe survey
(HTRU)

4 FRB + Lorimer discovery
(Lorimer et al. 2007)

Rate = $1.0^{+0.6}_{-0.5}$ * $10^4 day^{-1} sky^{-1}$
(one event per 1000 yrs per galaxy)
Redshift z = 0.5 - 1
Duration ~ 1 ms
S_ν ~ 0.5 - 1 Jy

Thornton et al.
Science 341, 53 (2013)

FAST RADIO BURSTS

FRB

↓

NS+NS

(Prediction: Lipunov & Panchenko 1996,
see also Hansen & Lyutikov 2001, Lyutikov 2013)

↓

Short GRB

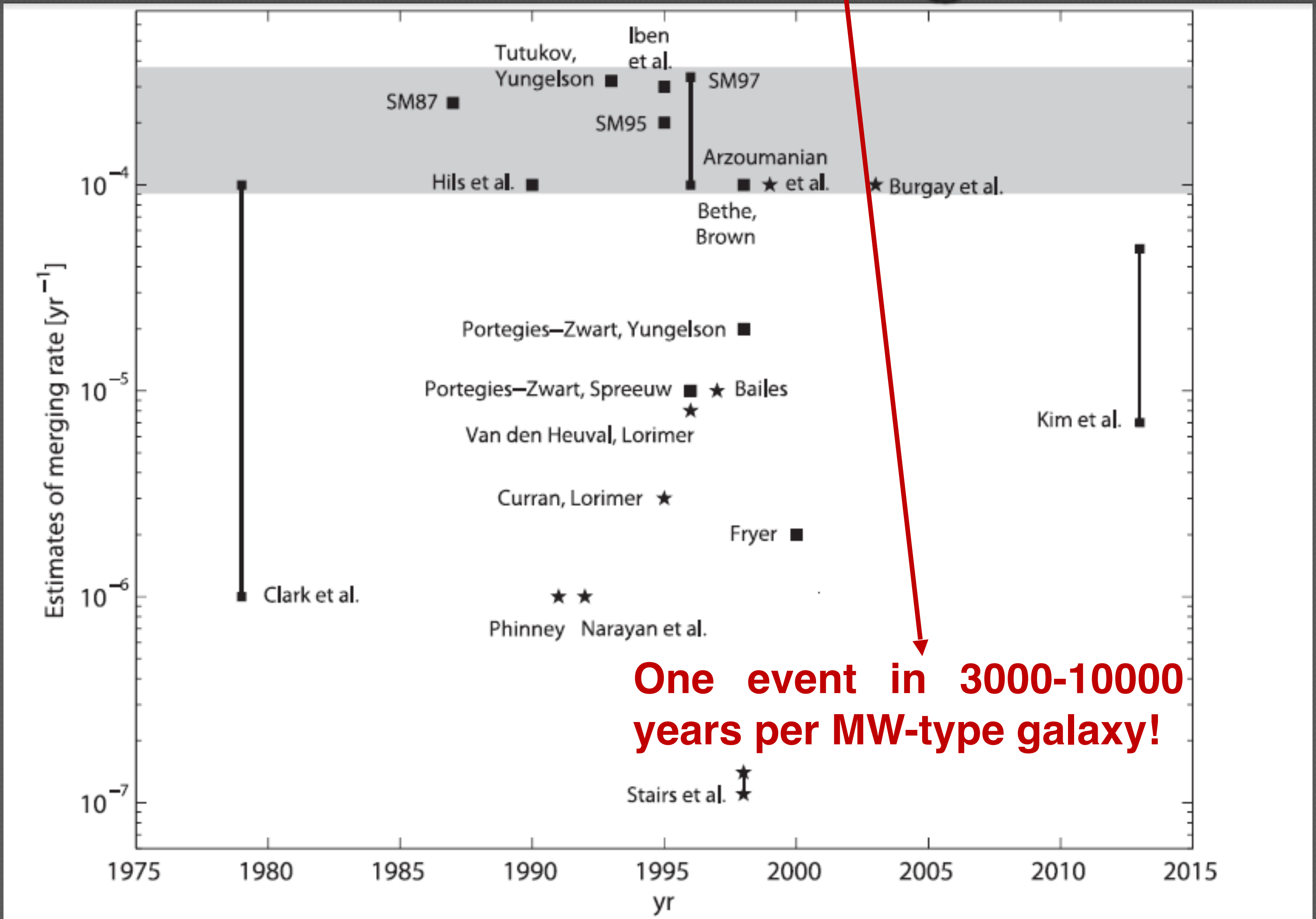
(Blinnikov et al. 1984, Paczynski 1986)

↓

GW (LIGO, Virgo etc.)

(Grishchuk et al. 2001)

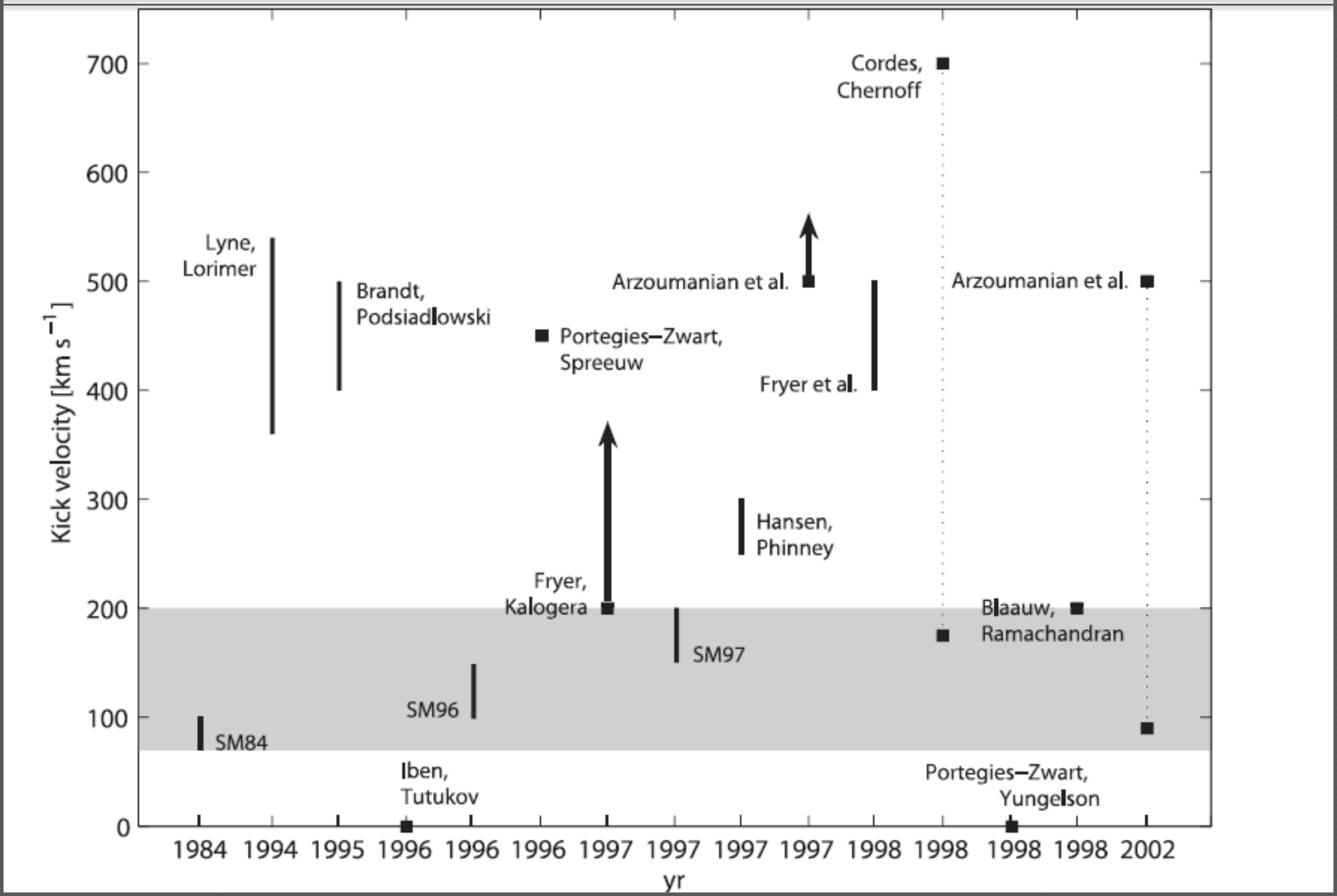
«Scenario Machine»* and neutron star merger rate

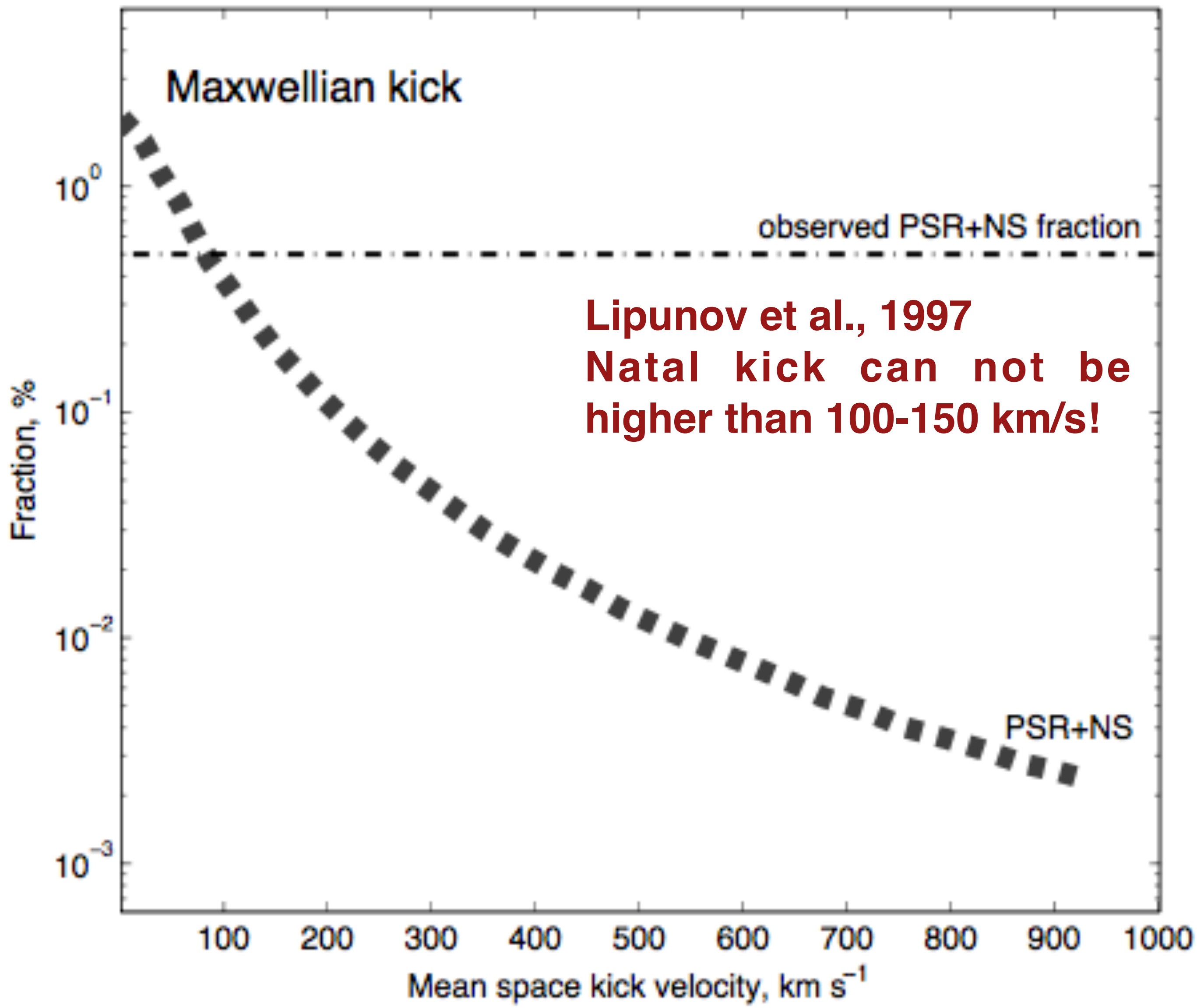


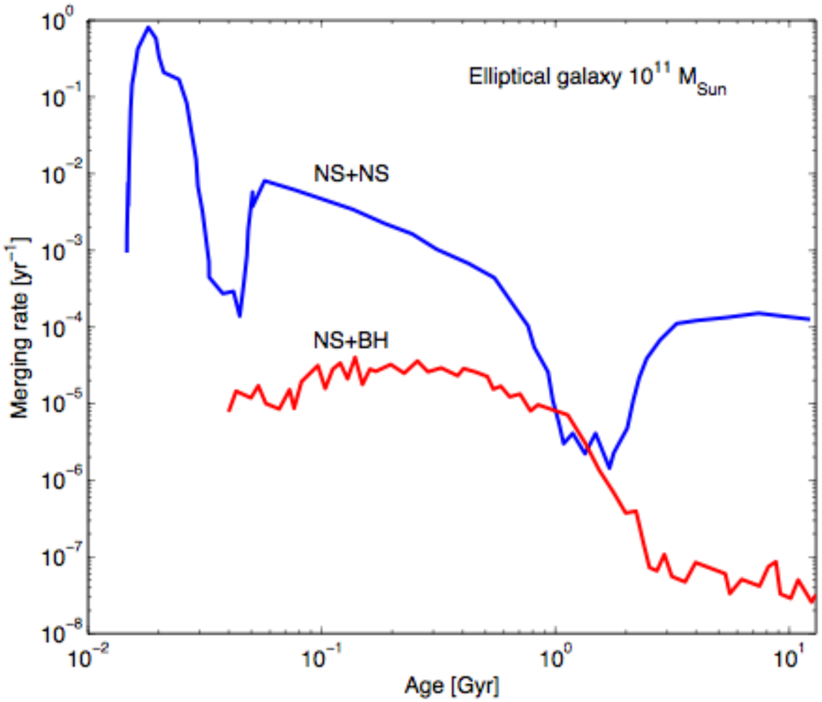
One event in 3000-10000 years per MW-type galaxy!

* See a monography Lipunov, Postnov & Prokhorov 1996

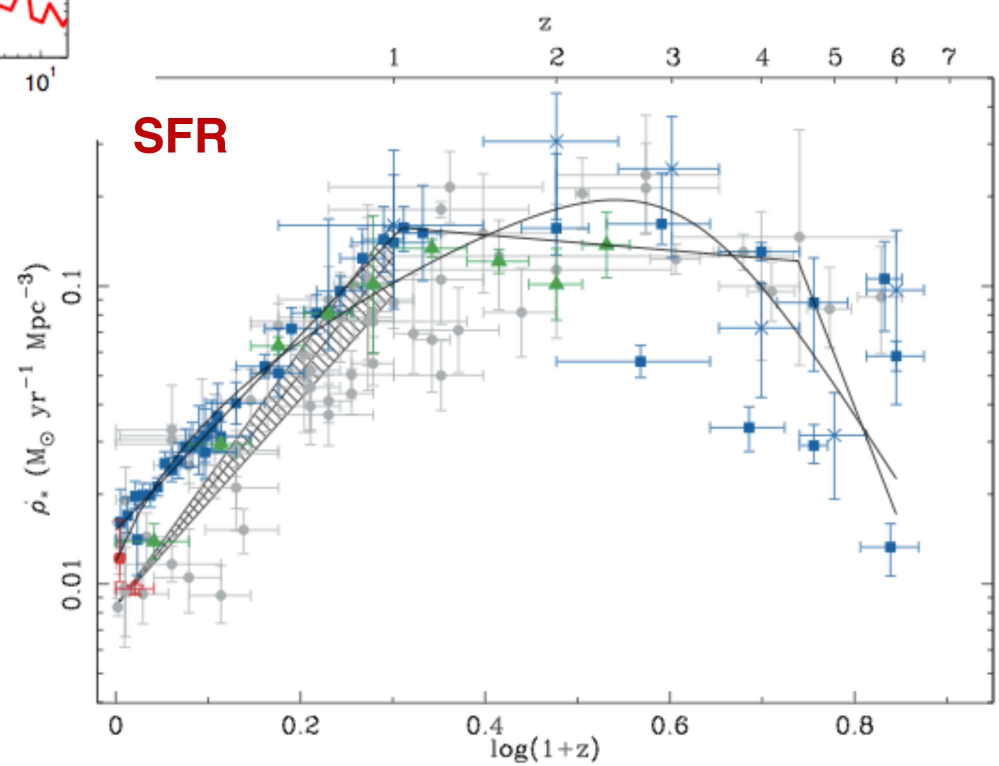
Kick velocity estimation by different authors




Maxwellian kick
observed PSR+NS fraction
Lipunov et al., 1997
Natal kick can not be higher than 100-150 km/s!
PSR+NS
Fraction, %
10^0
10^{-1}
10^{-2}
10^{-3}
100 200 300 400 500 600 700 800 900 1000
Mean space kick velocity, km s^{-1}



Temporal evolution of NS+NS (blue) and NS+BH (red) coalescence rates in elliptical galaxy with baryonic mass $10^{11} M_\odot$ after instantaneous star formation. **(Lipunov et al. 1995)**

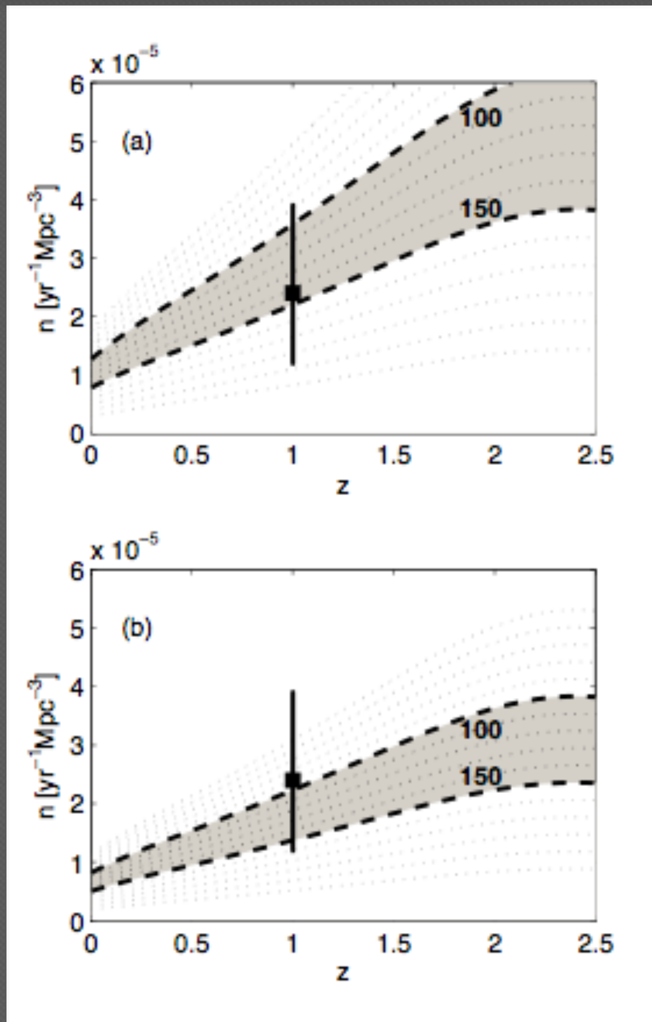


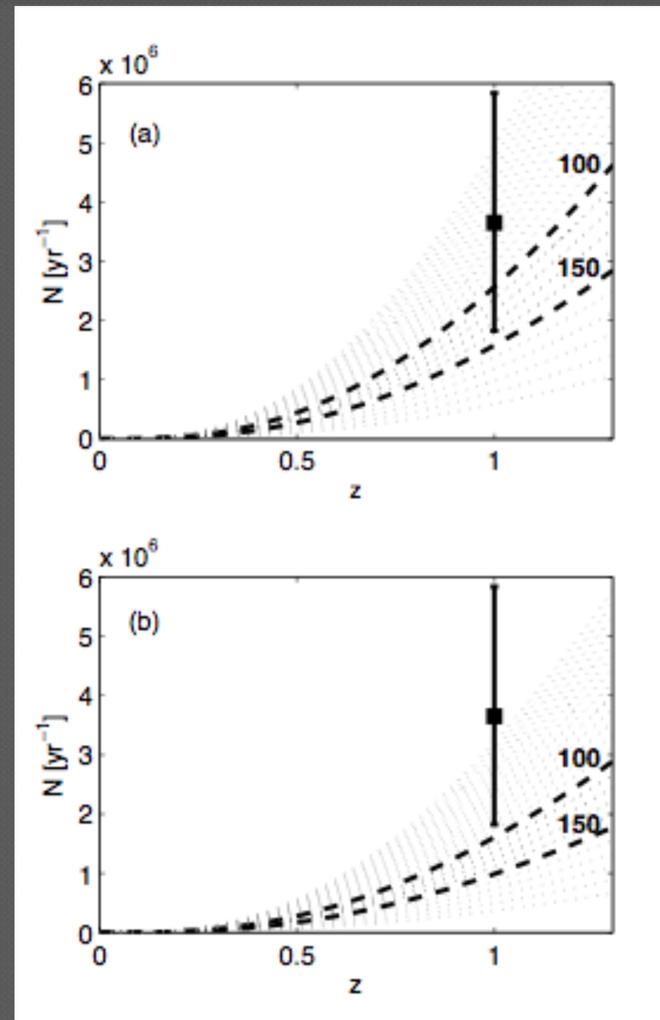
Star formation rate in the Universe. The compilation of UV, FIR, radio and Hα SFR data. **(Hopkins & Beacom 2006)**

NS merger rate vs. FRB rate

$$n(t) = \int_0^t SFR(\tau)G(t-\tau)d\tau;\ t \rightarrow z.$$

$$N(z) = 4\pi \int_0^z \frac{n[t(z)]D(z)^2 dD}{1+z},$$





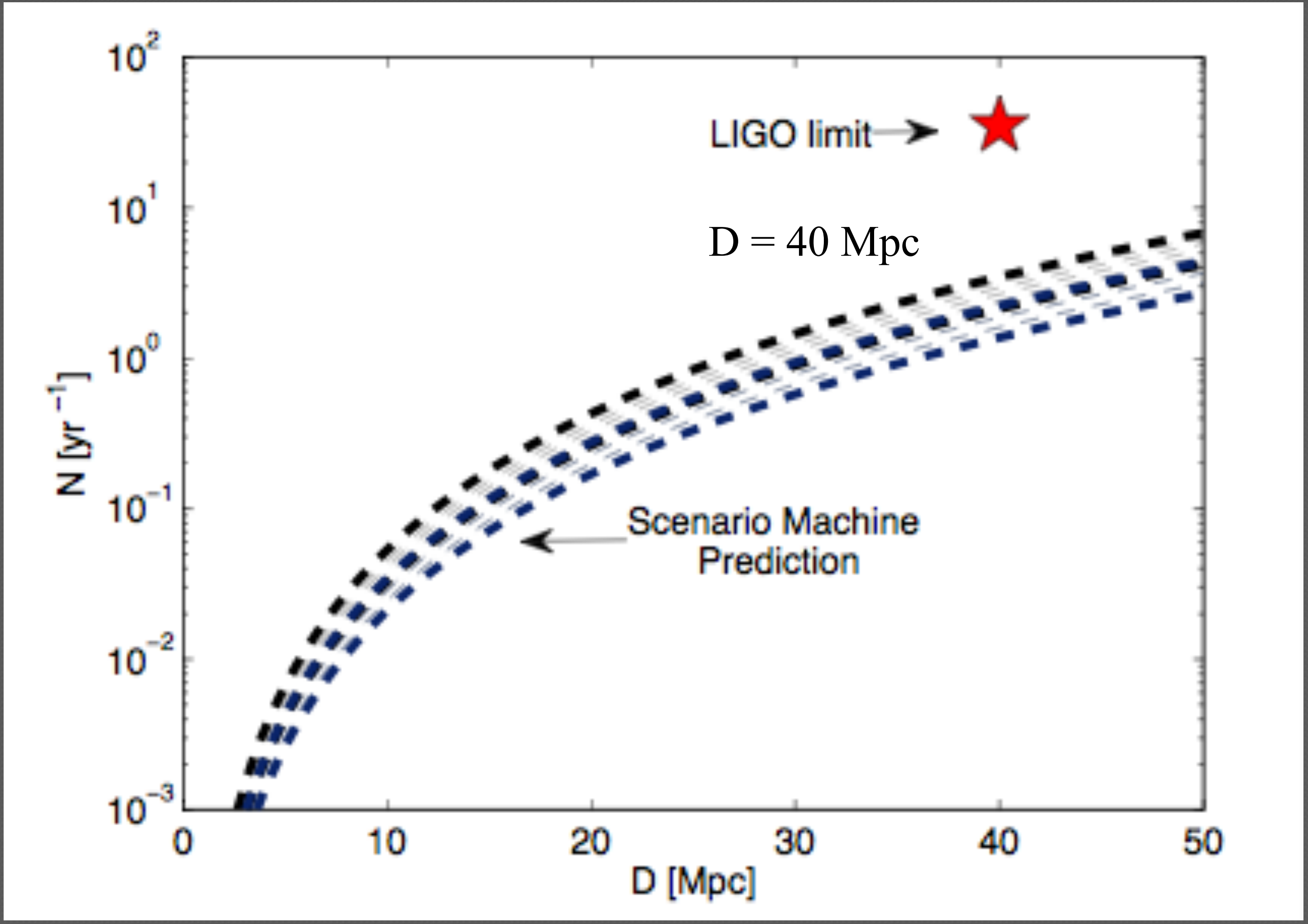
NS merger rate vs. FRB rate

For a kick velocity of 100-150 km/s
an average coalescence rate is one event in **500-2000** years
per galaxy in the comoving volume
corresponding to z = 0.5-1!!!

↕

FRB rate – one event in **1000** years per galaxy

LIGO silence



Conclusions

- We present for the first time the evolution of NS coalescence rate as a function of redshift in terms of a reasonable star formation function in the Universe.

- For a kick velocity of 100–150 km/s this function yields an average coalescence rate one event in 500–2000 years per galaxy in the comoving volume corresponding to $z = 0.5–1$, which is consistent with observational estimates for FRB.

- The fact that we did not detect any gravitational waves from NS mergers in LIGO search is consistent with our astronomical predictions.

Lipunov V. M., Pruzhinskaya M. V., «Scenario Machine: Fast Radio Bursts, Short GRB, Dark Energy and LIGO silence», *MNRAS*, vol. 440, 1193-1199, 2014


Thank you for your attention!
St. Petersburg, Russia, 2014

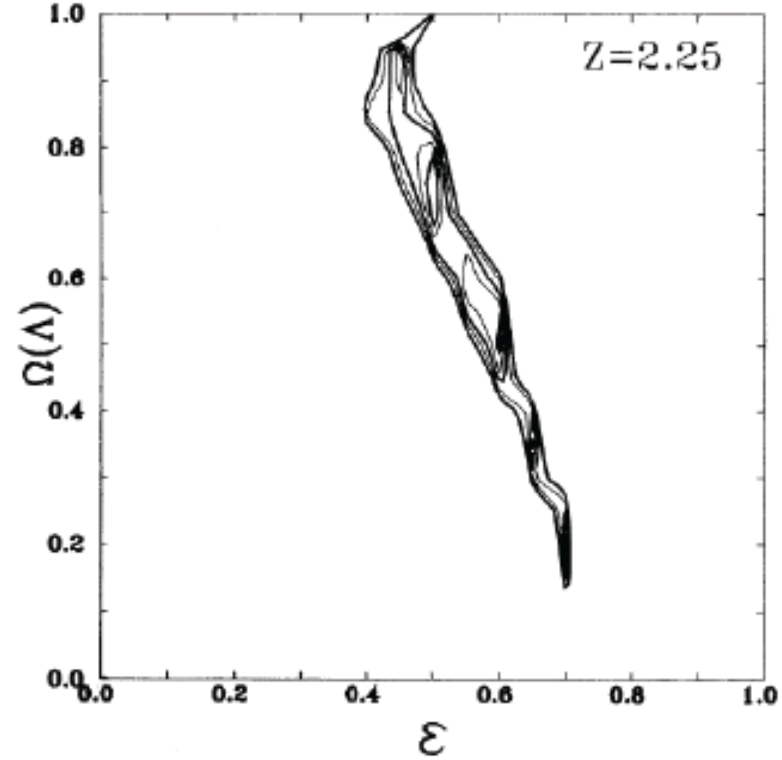


Figure 2. Dependence of dark-energy density on the fractional part of the luminous baryonic matter entering into the first-generation metal-poor stars (ϵ) estimated assuming that star formation rate peaked at about z = 2.25. According to modern data, the peak is located at about $\sim$ 2–2.5. Current value of $\Omega_\Lambda = 0.7$ (Perlmutter et al. 1999) gives $\epsilon \simeq 0.5$, which seems reasonable. The (90%, 91%, etc.) confidence level contours are shown for the ω^2 test in the $\epsilon - \Omega_\lambda$ plane at $z_* = 2.25$. A flat cosmological model and GRB spectral index s = 1.5 with the source evolution as in Fig. 4 are adopted (Lipunov et al. 1995).