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[FIRST J153350.8+272729: the radio afterglow of a decades-old tidal disruption event](https://arxiv.org/abs/2102.05795)

▶ details

We present the discovery of the fading radio transient FIRST J153350.8+272729. The source had a maximum observed 5-GHz radio luminosity of 8×10^39 erg s−1 in 1986, but by 2019 had faded by a factor of nearly 400. It is located 0.15 arcsec from the center of a galaxy (SDSS J153350.89+272729) at 147 Mpc, which shows weak Type II Seyfert activity. We show that a tidal disruption event (TDE) is the preferred scenario for FIRST J153350.8+272729, although it could plausibly be interpreted as the afterglow of a long-duration gamma-ray burst. This is only the second TDE candidate to be first discovered at radio wavelengths. Its luminosity fills a gap between the radio afterglows of sub-relativistic TDEs in the local universe, and relativistic TDEs at high redshifts. The unusual properties of FIRST J153350.8+272729 (ongoing nuclear activity in the host galaxy, high radio luminosity) motivate more extensive TDE searches in untargeted radio surveys.

- 变暗的射电暂现源 FIRST J153350.8+272729
- 5-GHz光度在1986年极大（$8 \times 10^{39} erg/s$），到2019年衰减了400倍。
- 距离一星系中心0.15角秒，光度距离147 Mpc（红移z=0.03243 ± 0.00001），该星系具有弱的II型Seyfert活动。
- 作者认为该射电源的对应体为TDE事件，尽管也可能是长伽玛暴的余辉。
- 这是第二个首先在射电波段被发现的TDE候选体。
- 该源的光度填补了邻近宇宙亚相对论TDE以及高红移相对论TDE之间射电余辉的空缺。
- 该源特殊的性质（宿主星系持续的核活动 nuclear activity 以及高射电光度）促使在射电巡天中进行更多TDE的搜寻。

- Q
  - 是先发现的这个源，做了证认后发现是一个之前已经观测过的源吗？1986年是怎么样观测的？
  - 什么是II型Seyfert活动？一种星系核活动？
  - 之前一直没有对该源分类吗，为什么认为是TDE事件？TDE事件的射电余辉能持续多久？为什么也可以用长伽玛暴解释，长爆的射电余辉可以持续这么久吗？
  - 为什么其它波段没有发现该源？
  - TDE射电余辉光度与红移有关？TDE的相对论性与红移有关？

- A

- 对VLASS一期前半(VLASS1.1, 应该是2017年)的数据以及FIRST(VLA Faint Images of the Radio Sky at Twenty centimeters) survey(1994-1999)的数据进行对比发现的。该源曾在1995年被FIRST探测到（流量密度9.7 mJy），但VLASS在2017年没有探测到（这是作者进行对比的一个标准，即找那些FIRST有，VLASS1.1没有的）。更进一步的数据搜索发现该源在1986年和1987年被Green Bank望远镜探测到，4.85GHz平均流量密度为51mJy。

Table 1. Radio Observations of FIRST J153350.8+272729.

Epoch	Survey	Frequency (GHz)	Flux density (mJy)
1968	Bologna	0.408	< 750
1974 − 1983	Texas	0.365	< 1200
1983 April 2 − 21	GBNSS	1.4	< 300
1986 November 6 − December 13	GB6	4.85	65 ± 8
1987 September 30 − November 1	GB6	4.85	42 ± 8
1987 January	GEETEE	0.0345	< 15000
1995 April 16	NVSS	1.4	9.1 ± 0.5
1995 November 65	FIRST	1.4	9.7 ± 0.1
1998 May 22	CLASS	8.46	< 1.5
2001 September 14	CLASS	1.425	< 3
2001 September 14	CLASS	4.86	< 1.5
2001 September 14	CLASS	8.46	< 1.5
2001 September 14	CLASS	22.46	< 7.5
2006	VLSSr	0.074	< 300
2010 April − 2012 March	TGSS	0.15	< 15
2017 October 2	VLASS	3	< 0.46
2019 May 14	19A-470	1.52	0.36 ± 0.03
2019 May 14	19A-470	5	0.132 ± 0.009
2019 May 14	19A-470	7	0.100 ± 0.009

- 该源曾出现在Green Bank 300-foot telescope 6 cm survey catalog中。

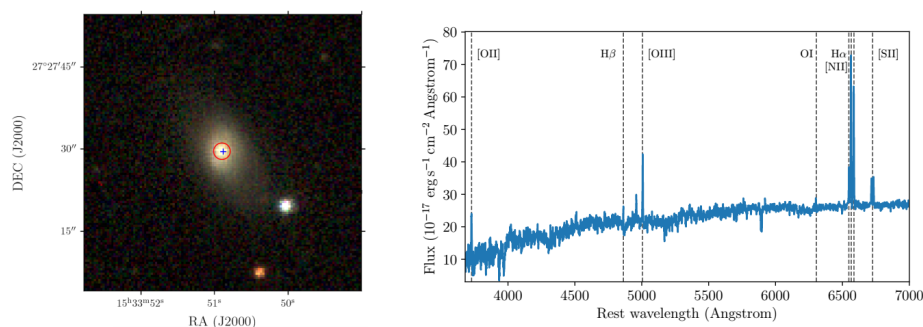- 作者在2019.3.14用VLA进行多波段观测，重新探测到了该源，5GHz流量密度仅为132 μJy（基本相当于上限）。33年内衰减400被，表明这是一个transient。

Figure 1. *Left:* Three-color composite in the SDSS g, r and i bands of the host galaxy of J1533+2727, SDSS J153350.89+272729. The radio position of J1533+2727 is shown as a blue cross, and the spatial extent of the SDSS fiber input on the sky is shown as a red circle (Smee et al. 2013). *Right:* SDSS spectrum (Ahumada et al. 2020) of SDSS J153350.89+272729 obtained on 2007 March 21. Some relevant emission lines are labeled, which are indicative of weak Type II Seyfert activity.

- II型Seyfert 活动特征

of just 107 pc. An inspection of the SDSS optical spectrum indicates weak Type II Seyfert activity, according to standard line-ratio diagnostics (Kewley et al. 2019), with $\log([NII]/H\alpha) = -0.05$ and $\log([OIII]/H\beta) = 0.78$. Stellar population synthesis fits to the SDSS pho-

- Seyfert星系核拥有非常明亮的辐射，中心存在超大质量黑洞及其吸积盘，主要光谱特征是具有强发射线。根据谱线特征不同分为不同的类型。大体上I型宽线居多，II型窄线居多。[wiki](#)

    Seyfert galaxies are one of the two largest groups of active galaxies, along with quasars. They have quasar-like nuclei (very luminous, distant and bright sources of electromagnetic radiation) with very high surface brightnesses whose spectra reveal strong, high-ionisation emission lines,[1] but unlike quasars, their host galaxies are clearly detectable.[2]

○ 对应体证认基本上是用排除法，排除了AGN的变化以及长爆余辉的情形。

We now interpret these observations in terms of three hypotheses for J1533+2727:

- AGN variability.

- An engine-driven transient associated with a supernova.[8]

- A jet or outflow powered by a TDE.

[8] We do not consider standard supernovae because the peak radio luminosity of J1533+2727 ($1.6 \times 10^{30}\,\mathrm{erg\,s^{-1}\,Hz^{-1}}$) is a factor of eight greater than even the most luminous radio supernova (PTF 11qcj; Palliyaguru et al. 2019).

- 排除AGN活动
    - 作者分别计算了ROSAT/PSPC 1990年和1991年在该源位置的上限，基于一定假设得出2-10KeV光度上限$L_X < 3.0 \times 10^{42}\,erg/s$以及$L_X < 2.6 \times 10^{41}\,erg/s$。根据星系黑洞质量和吸积物质的射电与X波段光度关系，作者计算出相应射电光度上限应该为$4.8 \times 10^{38}\,erg/s$以及$9.8 \times 10^{37}\,erg/s$，对应3.7mJy和0.8mJy。

    Gültekin et al. (2019). If J1533+2727 was indeed this faint during the X-ray observations, a much more rapid evolution is implied between the Green Bank 4.85 GHz detection and these epochs than at later times. Fur-

- 排除LGRB

However, the projected offset between J1533+2727 and the center of light of its host galaxy of $\approx 100\,\mathrm{pc}$ is inconsistent with more than 95% of the LGRB population (Lyman et al. 2017). Additionally, the high stellar mass and lack of evidence for an ongoing starburst in the host galaxy of J1533+2727 are inconsistent with typical LGRB hosts (Taggart & Perley 2019). We therefore favor the TDE scenario.

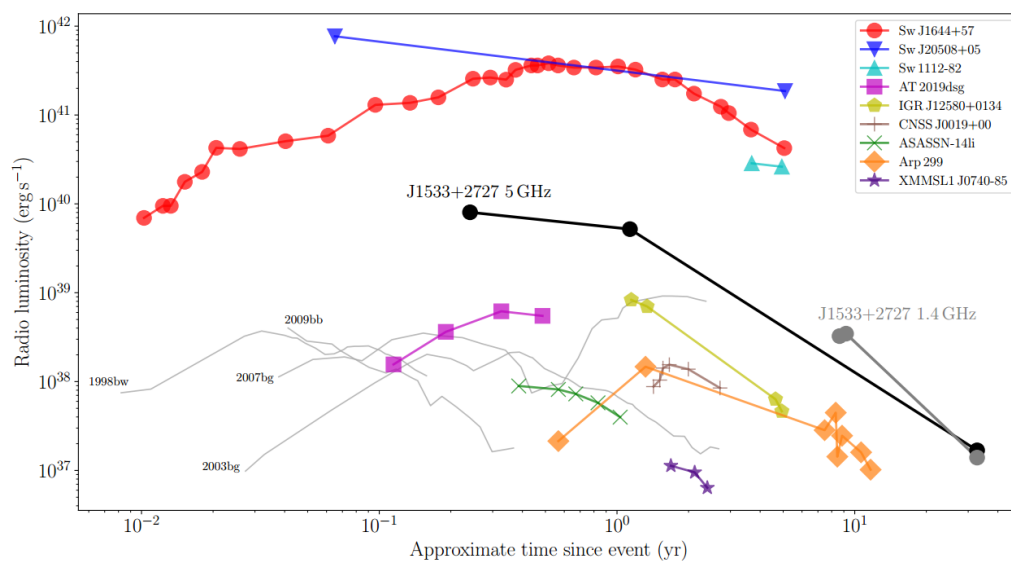- 该源在射电光度上填补了三个相对论性TDE事件及剩余的有射电探测的TDE事件间的空缺。相对论性TDE指具有相对论性喷流。不清楚剩余TDE的红移都是多少，估计射电光度不一定和红移有关系。

Figure 2. Lightcurves of all TDEs detected at radio wavelengths. All TDE data are at 5 GHz, except for the 1.4 GHz data

high redshift radio TDEs

...cataloged, only ~10% of TDEs emit radio emission (Alexander et al. 2020; Anderson et al. 2019). The three most distant of the radio TDEs (Sw J1644+57, Sw J2058+05, and Sw J1112-82 at redshifts of 0.35, 1.18, and 0.89 respectively) were first discovered through transient γ-ray emission corresponding to the launch of a nascent relativistic jet. The remaining radio TDEs are powered by mildly relativistic outflows that drive shocks

- implications?

- Knowledges
  - the radio emission generated by extragalactic explosions (e.g., supernovae, γ-ray bursts, and TDEs) is enhanced in the presence of **more energetic outflows,and denser circum-explosion material**.

Periodic Fast Radio Bursts from ULX-Like Binaries

https://arxiv.org/abs/2102.06138

▶ details

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The discovery of periodicity in the arrival times of the fast radio bursts (FRB) from two repeating sources poses a potential challenge to oft studied magnetar scenarios. However, models which postulate that FRB emission results from relativistic magnetized shocks, or magnetic reconnection in a striped outflow, are not necessarily specific to magnetar engines, instead requiring only the impulsive injection of relativistic energy into a dense magnetized medium. Motivated thus, we outline a new scenario in which FRBs are powered by short-lived relativistic outflows ("flares") from accreting black hole or neutron star systems, which propagate into the cavity of the pre-existing ("quiescent") jet. In order

to reproduce FRB luminosities and rates, we are driven to consider binaries of stellar-mass compact objects undergoing super-Eddington mass transfer, similar to those which characterize some ultra-luminous X-ray (ULX) sources. Indeed, the host galaxies of FRBs, and their spatial offsets within their hosts, show broad similarities to those of ULX. Periodicity on timescales of days to years could be attributed to precession (e.g., Lens-Thirring) of the polar accretion funnel, along which the FRB emission is geometrically and relativistically beamed, across the observer line of sight. Accounting for the most luminous FRBs via accretion power may require a population of binaries undergoing brief-lived phases of unstable (dynamical timescale) mass transfer. This could lead to secular evolution in the burst properties of some repeating FRB sources on timescales as short as months to years, followed by a transient optical/IR counterpart akin to a luminous red nova or dusty common envelope transient. We encourage targeted FRB searches of known ULX sources.

- FRB不一定起源于磁星，只需要存在"the impulsive injection of relativistic energy into a dense magnetized medium"。
- 作者提出FRB可能源于于吸积中的黑洞或中子星系统中短暂存在的相对论性外流（耀发），它们传播到cavity of the pre-existing ("quiescent") jet 从而造成FRB。？？？
- 作者考虑了正经历"super-Eddington mass transfer"的太阳质量致密双星的模型，与ULX（ultra-luminous X-ray soruces）的模型类似。
- 这种情形下，FRB的周期性可能来自于吸积系统的进动。
- 那些最亮的FRB可能产生于质量转移不稳定的双星，这样会导致爆发性质的演化（月到年），并且伴随与"a luminous red nova or dusty common envelope transient"相似的光学/红外暂现源对应体。
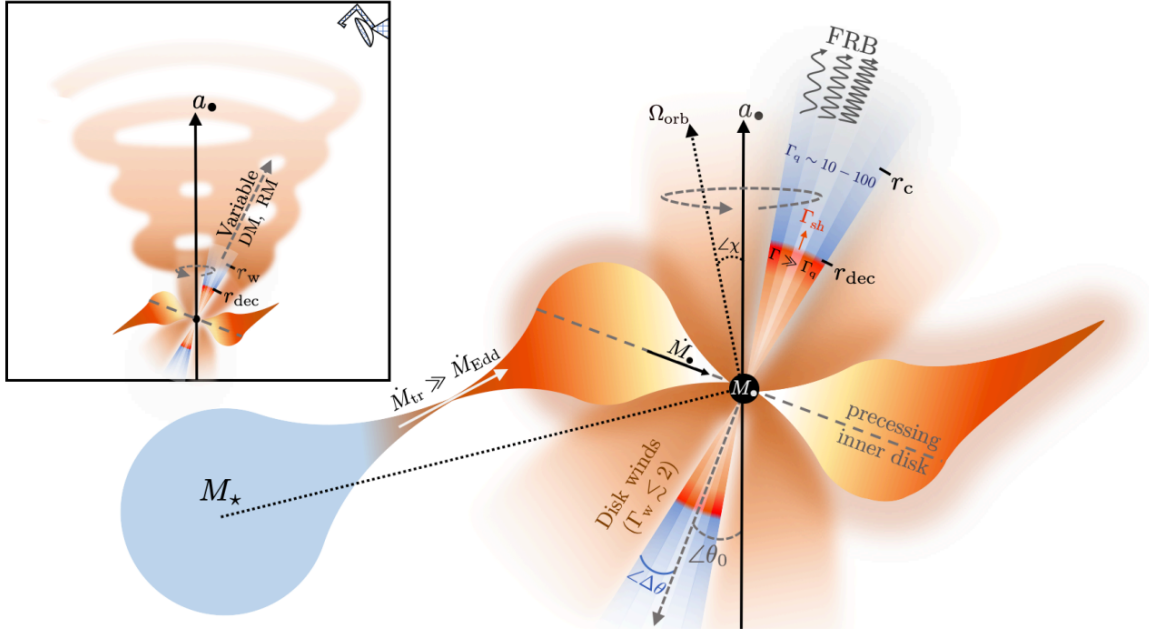
Figure 1: Schematic diagram of the production of periodic FRBs from accretion-powered flares in ULX-like binaries outlined in this paper. A star of mass $M_\star$ undergoes thermal- or dynamical-timescale mass-transfer onto a compact BH or NS remnant of mass $M_\bullet$ at rate $\dot{M}_{\rm tr}$ near or exceeding the Eddington rate. The super-Eddington accretion flow is radiatively-inefficient and hence subject to powerful outflows, which can reduce the accretion rate reaching the central compact object, $\dot{M}_\bullet \ll \dot{M}_{\rm tr}$. The mass-loaded disk winds also shape the narrow polar accretion funnel of half-opening angle $\Delta\theta$ and corresponding beaming fraction $f_{\rm b}$. FRB emission is generated by a relativistic flare of energy released close to the innermost stable circular orbit (e.g. due to reconnection of magnetic field lines threading the BH horizon), which propagates outwards along the accretion funnel as an ultrarelativistic shock into the cavity of the previous "quiescent" jet. Coherent radio emission (the FRB) is generated via the synchorotron maser shock mechanism or magnetic reconnection within the relativistic flow (at radii $\gg r_{\rm c}$, above which induced Compton scattering in the quiescent jet is negligible; eq. 8). If the spin axis of the BH is misaligned with respect to the angular momentum axis of the accretion disk, the polar cavity−and hence the direction along which the FRB emission is geometrically beamed−is modulated by Lens-Thirring precession on a timescale of days to years (eq. 27). *Inset:* The magnetized disk outflows are swept into a spiral pattern due to the precession of the disk angular momentum about the axis of BH spin ($a_\bullet$). The instantaneous jet axis intersects this wind (from an earlier precession phase) on larger scales $\gtrsim r_{\rm w}$ (eq. 33). Small systematic variations in the burst DM and RM are expected due to this encounter (eq. 35).