

Unveiling the origin of Fast Radio Bursts
by localizing them to milliarcsecond resolution

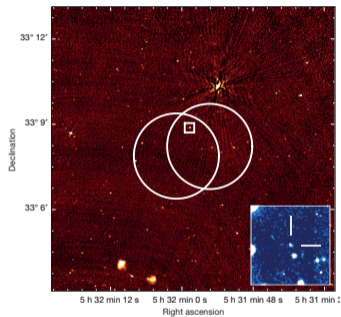
Benito Marcote

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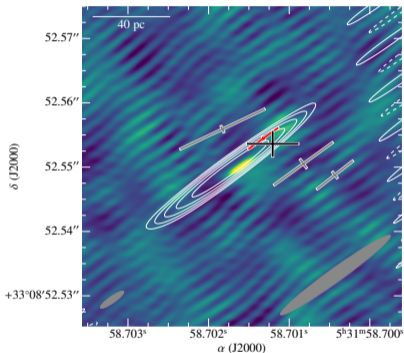


JIVE

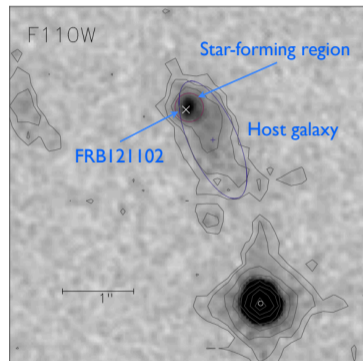
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ERIC



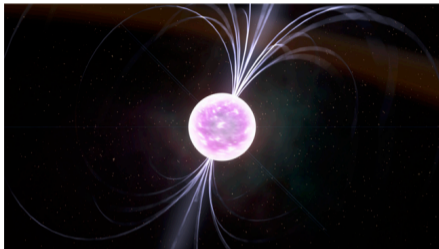
Chatterjee et al.
(2017, Nature, 541, 58)



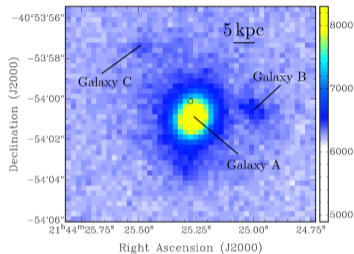
Marcote et al. (2017, ApJL, 834, 8)



Tendulkar et al. (2017, ApJL, 834, 7)
Bassa et al. (2017, ApJL, 843, 8)

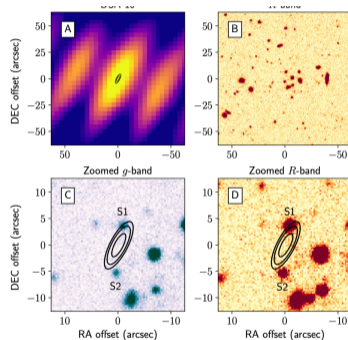


- Pulsar/magnetar powering up a young superluminous supernovae?
(e.g. Margalit et al. 2018, Metzger & Margalit et al. 2019)
- Young pulsar/magnetar interacting with a massive black hole?
(e.g. Pen & Connor 2015, Cordes & Wasserman 2016, Zhang 2018)



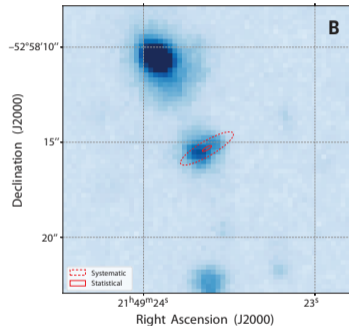
Lenticular galaxy at $z \sim 0.3$

Bannister et al. (2019)



Elliptical galaxy at $z \sim 0.66$

Ravi et al. (2019)



Star-forming galaxy at $z \sim 0.5$

Prochaska et al. (2019)

Following CHIME FRB repeaters with the EVN



Image by Paul Boven (boven@jive.eu). Satellite image: Blue Marble Next Generation, courtesy of Nasa Visible Earth (visibleearth.nasa.gov).

The precise localization of a second repeating FRB



CHIME/FRB exhibits a ~ 3 arcmin position uncertainty

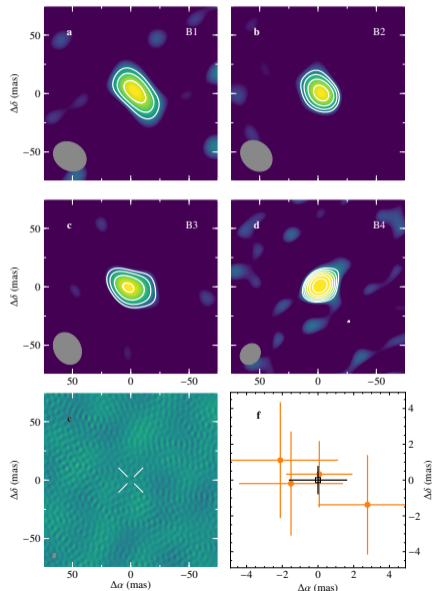
Hundreds of FRBs discovered by them

A fraction of them do repeat

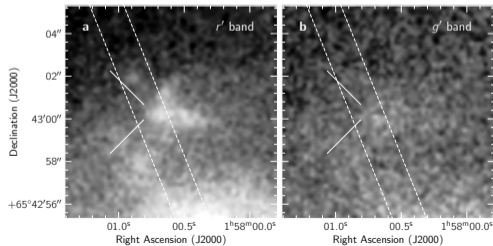
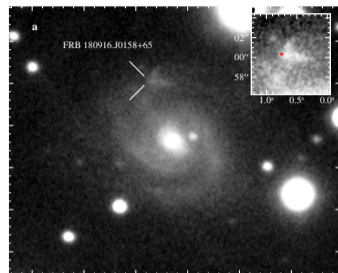
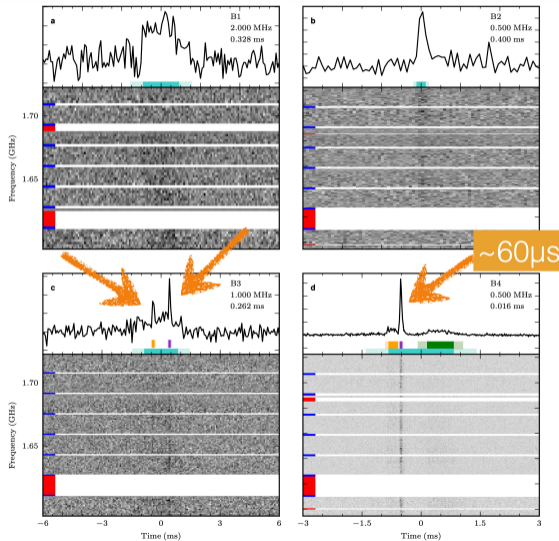
EVN observations of CHIME repeaters since 2018
(PIs: Marcote, Nimmo, Kirsten)

FRB 180916.J0158+65 was potentially the closest and most active one

Marcote et al. (2020, Nature, 577, 190)

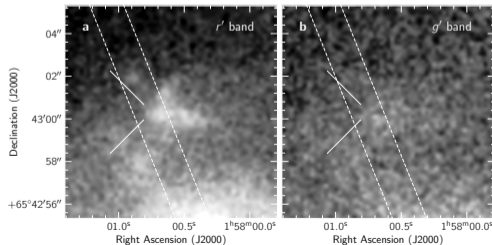
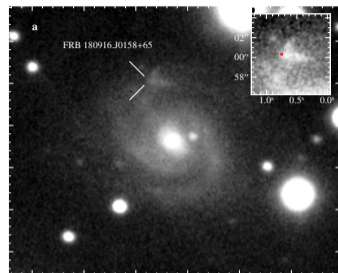


The precise localization of a second repeating FRB





- Spiral galaxy ($10^{10} M_{\odot}$)
- $z = 0.0337(2) \Rightarrow D_L \approx 149$ Mpc
- V-shaped star-forming region
 $\sim 10^{-2} M_{\odot} \text{ yr}^{-1} \text{ kpc}^{-2}$
Metallicity: $12 + \log(\text{O}/\text{H}) = 8.82$
- No persistent emission
 $< 7.6 \times 10^{35} \text{ erg s}^{-1}$ (3σ)
400 times fainter than FRB 121102
- Bursts $\sim 5 \times 10^{27} \text{ erg Hz}^{-1}$
- ~ 300 -yr old magnetar source? 16-d Binary system?

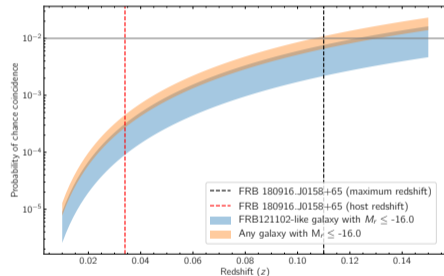




- **FRB 180916.J0158+65 is the closest extragalactic FRB localized to date**
(and the second repeating FRB)
- Burst energies span up to six orders of magnitude.
- Diminishing the existence of two population of FRBs (repeating and non-repeating).
- Multiple types of sources can produce fast radio bursts?
- More precise localizations revealing the local environments of FRBs are necessary
VLBI observations are the only one capable of such resolution

Thank you!

Probability for change coincidence



- $< 1\%$ for any type of galaxy with mass greater than about 40% of the FRB 121102.