The 2017 INTEGRAL campaign of the Fast Radio Burst FRB121102: results and prospects

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Fast Radio bursts

- Discovered in 2007 (Lorimer burst)
- Bright, short radio pulses
- High dispersion measure (DM)
- Extragalactic origin
- Cataclysmic event?
Till 2018, only one repeating Fast Radio Burst : FRB121102
A very brief history of the Fast Radio Burst FRB121102

- Discovery at Arecibo/PALFA survey, 2012 November 2 (Spitzer et al, 2014)
- Follow-up Arecibo 10 new bursts detected —> FRB121102 is a repeating burst (Spitler et al, 2016)
- Follow-up: Arecibo, Effelsberg, Green Bank telescope, Lowell telescope, VLA
  → 6 more bursts (Scholz et al, 2016)
  N=17 bursts

- VLA follow up: 83h distributed over 6 months → 9 bursts detected in 2016
  + Optical identification of the host galaxy (Chatterjee et al, 2017)
  • accurate localization <100 mas
  • persistent radio and optical counterpart
  N=26 bursts

- European VLBI networks + 305m-Arecibo telescope: detects both the bursts (4) and persistent radio emission at millisecond angular scale, persistent radio source less than 0.7 pc (Marcote et al, 2017)
  N=30 bursts

- Gemini + GMOS Optical observation: low-metallicity dwarf galaxy at z=0.192, Persistent radio source offset by 200 mas from the galaxy’s center
  No optical signatures for AGN activity (Tendulkar et al, 2017)
(Spitler, private com.)
Many theoretical models proposed for FRB121102

- Collapses of supra-massive neutron star into black hole (Falcke et al, 2014, Zhang et al, 2014)
- Magnetar pulse-wind interactions (Lyubarsky, 2014)
- Charged black hole binary mergers (Zhang et al, 2016)
- Giant pulse emissions from pulsars (Cordes et al, 2016)
- Unipolar inductor model (Wang et al, 2016)
- Double neutron stars mergers (Totani et al, 2013)
- Encontering of many asteroids with a highly magnetised pulsar (Dai et al, 2016)
- Radio emissions from pulsar companions (Mottez et al, 2014)
- Magnetic energy release in magnetar magnetosphere (Katz J.I, 2016)
- Extreme environment: “An extreme magneto-ionic environment associated with fast radio burst source FRB121102.”, Michilli et al, Nature, January 11th, 2018: Polarization (nearly 100%) → emission close to a massive black hole or within a very powerful nebula
- …
Several arguments to search for a counterpart/afterglow of FRB’s in \( \lambda \neq \text{radio} \)

- Important to look for afterglow
- Several models predict extended gamma-ray emission (Murase et al, 2017)
- Search for the host galaxy when possible (precision of the localization)
- A possible afterglow detected by Swift/BAT from FRB131104 (Delaunay et al, 2016)

Two orbits allocated late September 2017, multi-\( \lambda \) campaign organized
Several facilities involved
The optical/radio campaign (planned)
Several facilities involved
BUT…..
But Nature sometimes not very cooperative:

- Hurricane Maria
- Nançay technical problem
Radio coverage

- **Effelsberg** (Laura Spitler)
  1. 2017-09-24 23:17:54.000 UTC to 2017-09-25 08:19:17.000 UTC
  2. 2017-09-25 23:19:57.000 UTC to 2017-09-26 08:21:20.000 UTC
  3. 2017-09-26 23:28:52.000 UTC to 2017-09-27 08:06:42.000 UTC
  4. 2017-09-27 23:26:49.000 UTC to 2017-09-28 05:27:48.000 UTC

- **GBT** (Ryan S. Lynch)
  Sept 24 10:45 -- 14:00 UT
  Sept 25 06:00 -- 08:00 UT
  Sept 25 10:45 -- 17:45 UT
  Sept 26 05:45 -- 08:30 UT
  Sept 27 06:00 -- 08:30 UT
  Sept 27 10:45 -- 18:00 UT
  Sept 28 06:00 -- 08:30 UT

- **FAST** (Lei Qian)
  20170929 06:45-07:45 —> UT 2018 09 28 22h45-23:45
  20170928 07:43-07:55 —> UT 2018 09 27 23h43-23h55
  20170926 07:00-08:00 —> UT 2018 09 25 23h00-24h00
  20170925 07:25-08:00 —> UT 2018 09 24 23h25-24h00
VHE complementary observations
(thanks to support from Fabian Schussler, CEA)

- **MAGIC** (susumu.inoue@riken.jp)
  24-25.9.2017 02:34 - 04:35 UT
  25-26.9.2017 02:30 - 04:28 UT

- **VERITAS** (ralph.bird.1@gmail.com)
  09/25 10:45-12:00 UT
  09/27 10:45-11:45 UT

- **HESS** (fabian.schussler@cea.fr)
  26/27 Sep 2017: 2:29 - 3:22 (~2min gap at 02:57)
  27/28 Sep 2017: 2:20 - 3:17 (~2min gap at 02:48)
Revolution 1867
20-100 keV
20 – 40 keV : 0.95 sigma
40 – 60 keV : 1.01 sigma
60 – 100 keV : -0.22 sigma
100 – 200 keV : 0.55 sigma
Optical campaign: Instrument GASP (Galway Astronomical Stokes Polarimeter) @ OHP T193cm
See Andy Shearer’s poster
See Andy Shearer’s poster
FRB121102 at OHP193cm+GASP
10x1 sec expo, R filter
The campaign, Sept. 2017

✓ INTEGRAL OK
✓ Good radio coverage (even if Arecibo and Nançay not part of the campaign)
✓ Some extra VHE observations
✓ OHP+T193cm + GASP excellent run

BUT No radio bursts detected in 60 hours from Effelsberg + GBT (means no trigger for INTEGRAL/OHP analysis)
Our September 2017 campaign

ATEL #10675  GBT, 15 bursts in 1 hour

Date (MJD)

June 2016  February 2017  July 2017

Active  Quiet  Active  Quiet
New strategy

Daily monitoring of FRB121102 with the Nançay Radio Telescope

Criteria: Trigger the INTEGRAL ToO (+others) when radio bursts detected in at least in 2 over 3 one hour long successive observations with NRT (Nançay Radio Telescope) (+supporting observations with Arecibo and Effelsberg)
FRB121102 at Nançay radio telescope
Prospects/actions :

✓ Monitoring with Nançay (+ other supports) going on : Stay tuned !
✓ Welcome to participate/join to the radio/optical campaign (please contact us)
✓ Next week (18 - 20 February, 2019) FRB2019 meeting at Amsterdam on « Fast radio bursts and their possible neutron star origins »
✓ FRB and GRB : some similarities (discovery, timescale of the phenomena, unknown type of sources, alert, follow-up strategy, instrumental developments, etc)
✓ Surely more FRBs discovered very soon (CHIME, ASKAP) with much more precise localization (a key issue to study FRB’s environment)
✓ Repeating vs no repeating : 2 different types of sources ?
The Canadian Hydrogen Intensity Mapping Experiment

Discovery of a second source of Repeating Fast Radio Bursts
FRB 180814.J0422+73
(Chime collaboration, 2019, Nature)
Discovery of a second source of Repeating Fast Radio Bursts
FRB 180814.J0422+73

Chime collaboration, 2019, Nature
A final remark:

FRB121102 and FRB 180814.J0422+73 nearly same right ascension (and both northern objects)

→

can be observed with the same facility (optical, radio) if triggered

Difficult choice if both active at the same time!

Thank You