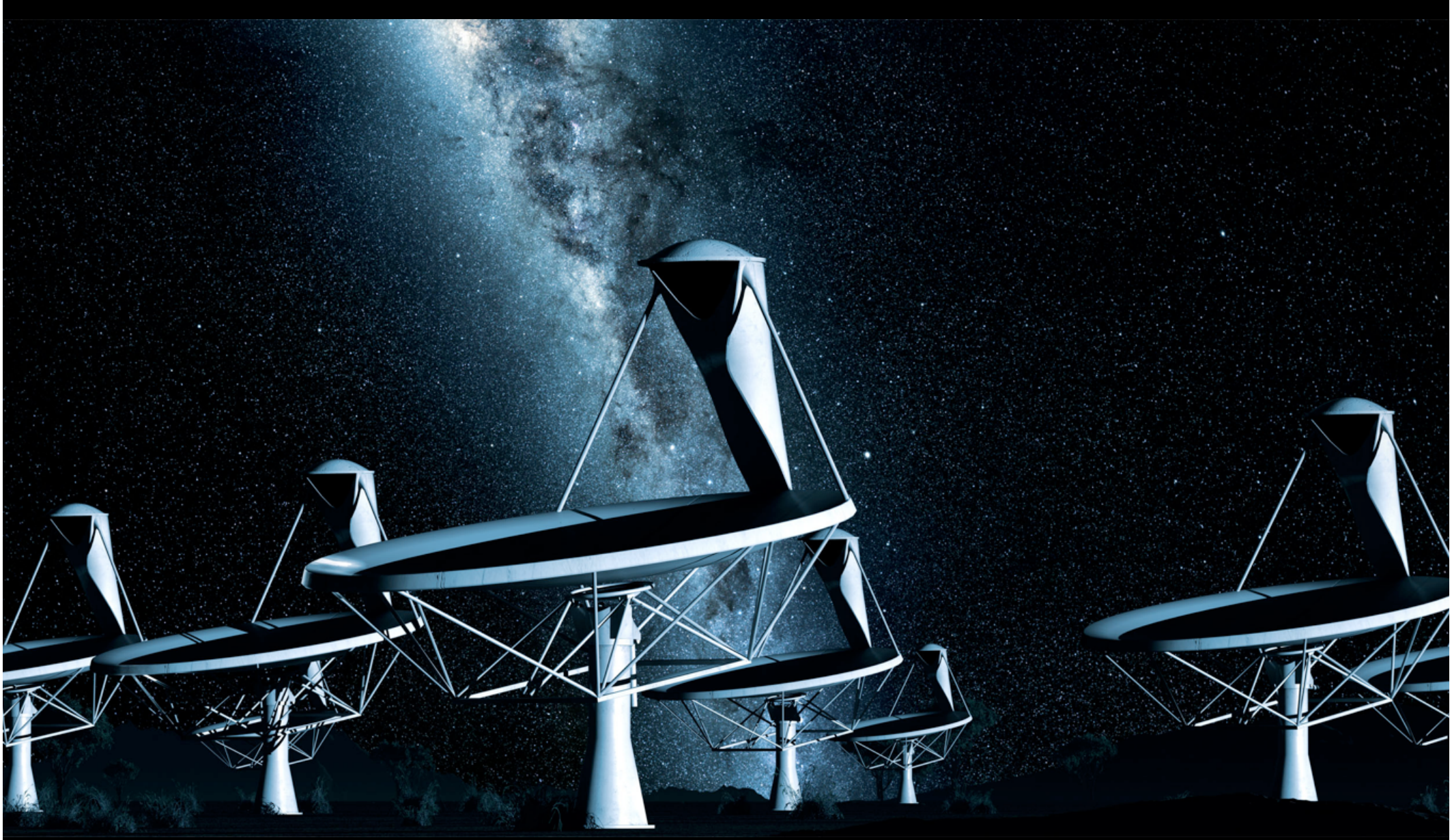
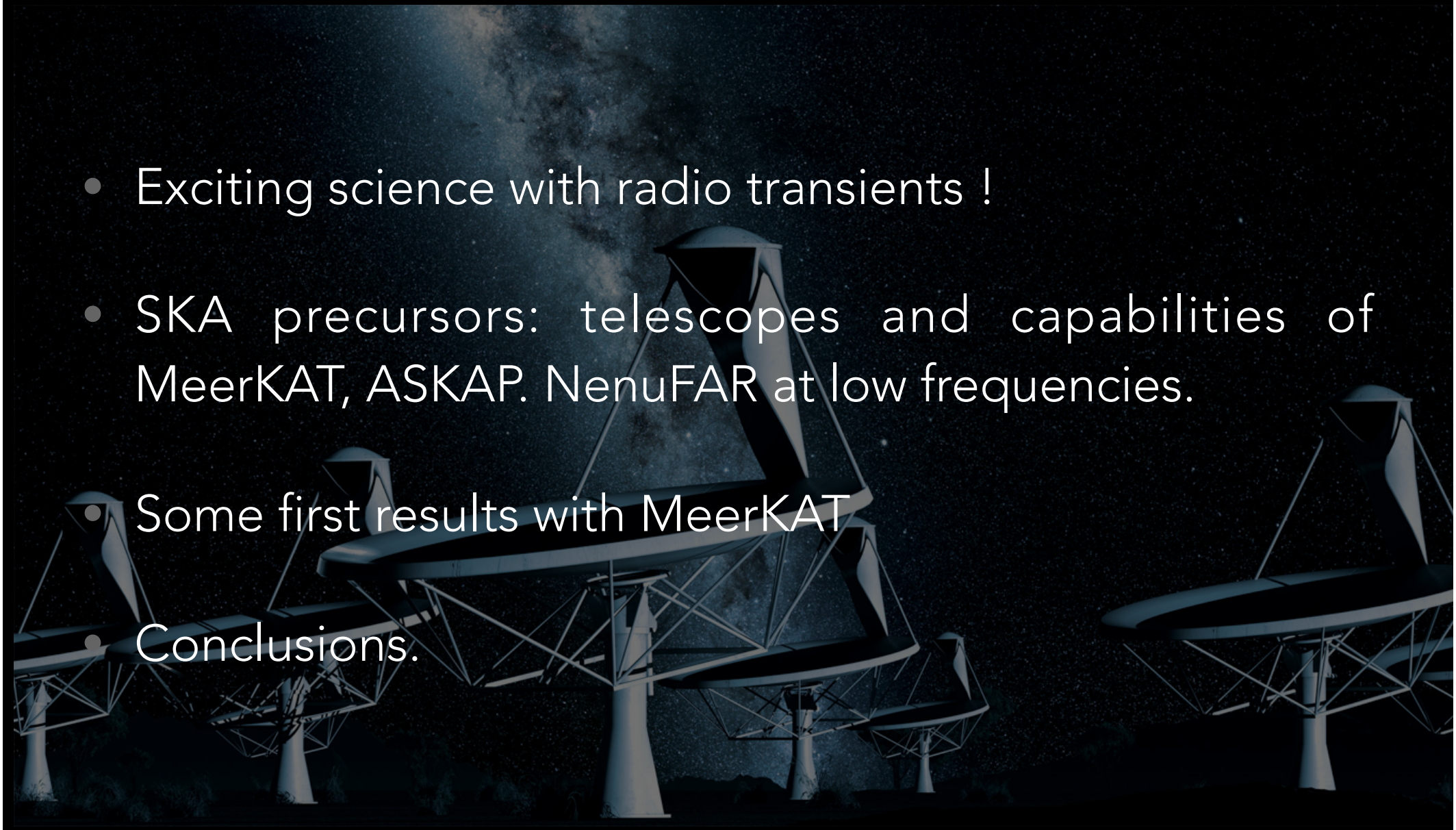


TRANSIENTS WITH SKA PRECURSORS AND PATHFINDERS

S. CORBEL (UNIV. PARIS & CEA SACLAY/AIM & OBS. PARIS/USN)

OUTLINE



- Exciting science with radio transients !
- SKA precursors: telescopes and capabilities of MeerKAT, ASKAP. NenuFAR at low frequencies.
- Some first results with MeerKAT
- Conclusions.

RADIO TRANSIENTS

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- Exploring the extreme events in the Universe: brightest, fastest, hottest, densest, most massive, most magnetized, …. + the Unknown !

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  - **Incoherent** synchrotron from explosive events ($T_b < 10^{12}$ K), images, **slow transients.**

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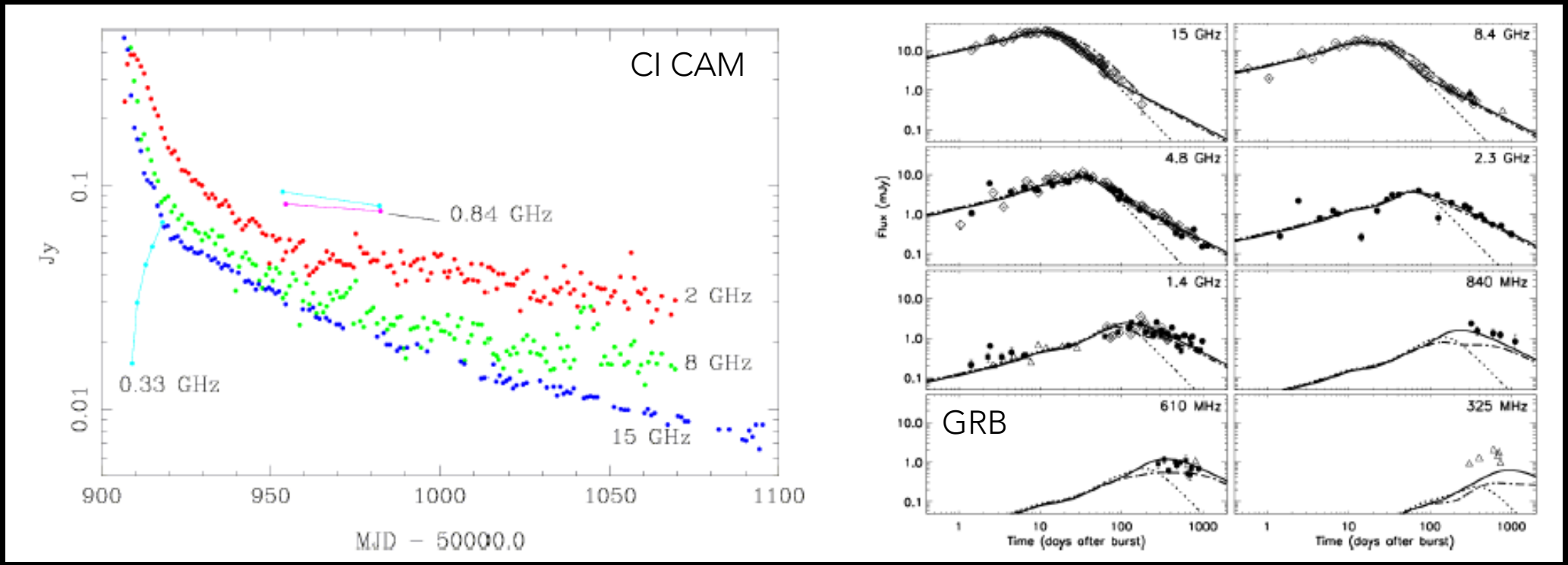

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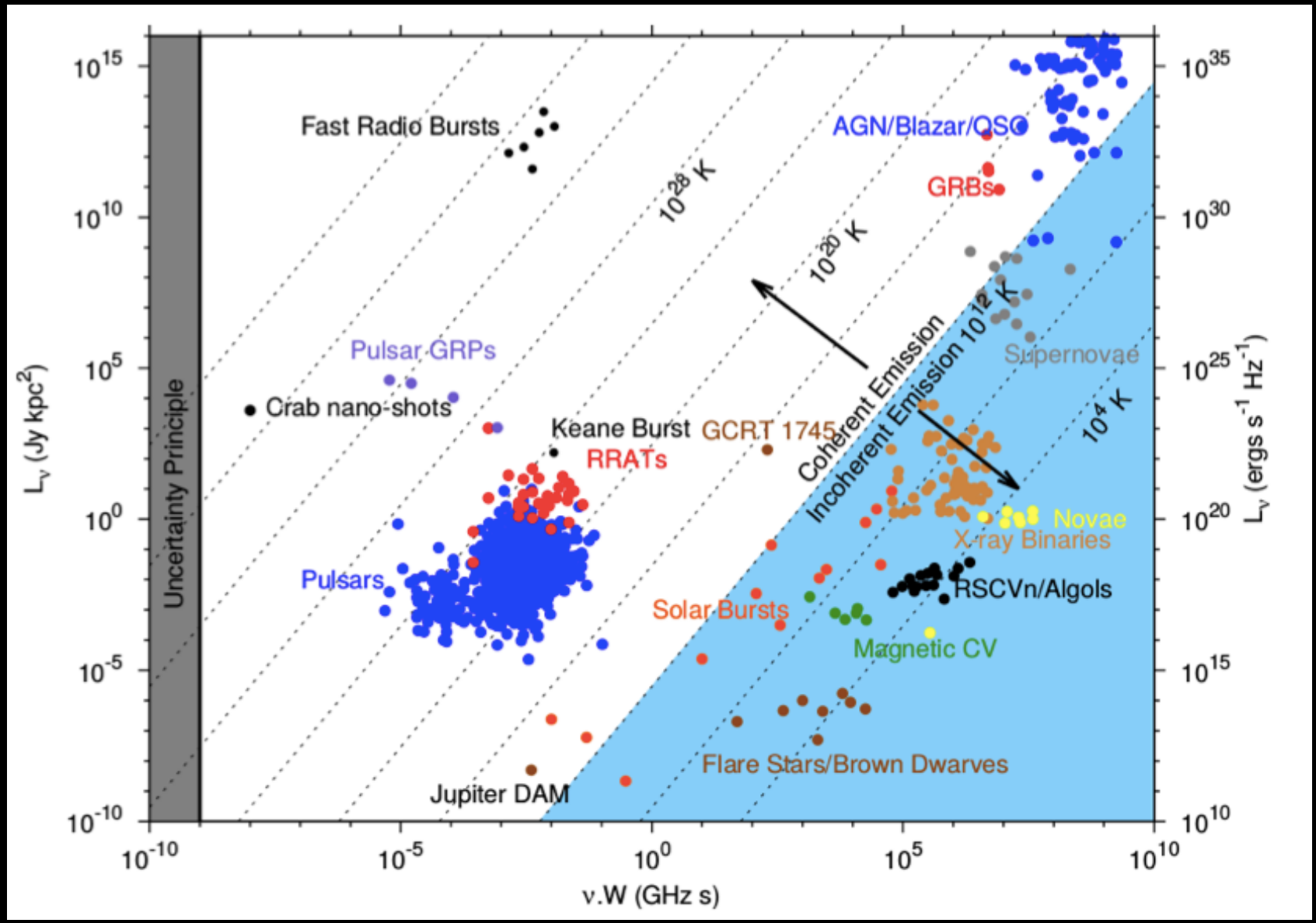
- « Slow » Transients: explosive injection of energy into an ambient medium —> shocks —> particles acceleration up to HE + synchrotron emission:

  - **XRBs** (BH, NS, WD), ULX, Isolated BH, magnetar, SNe, TDEs, AGNs, GRBs, Novae, ….

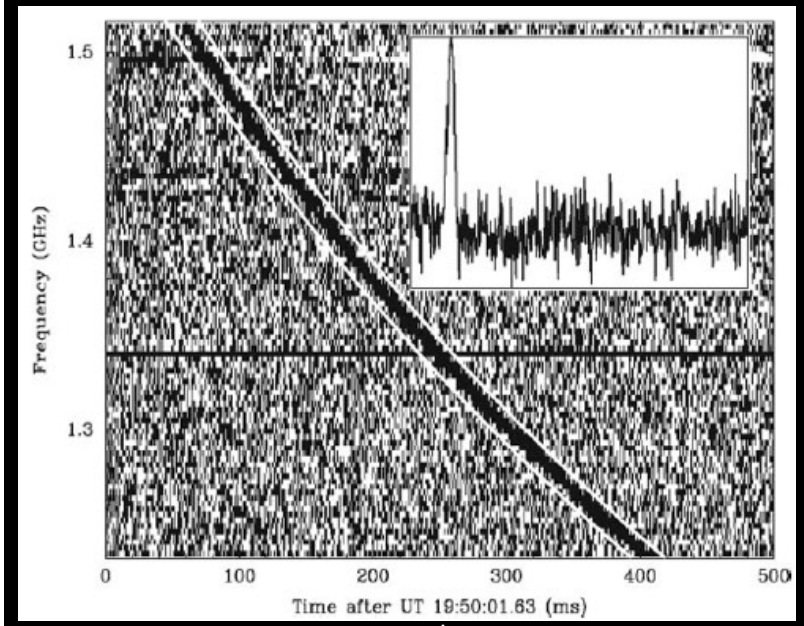
RADIO TRANSIENTS



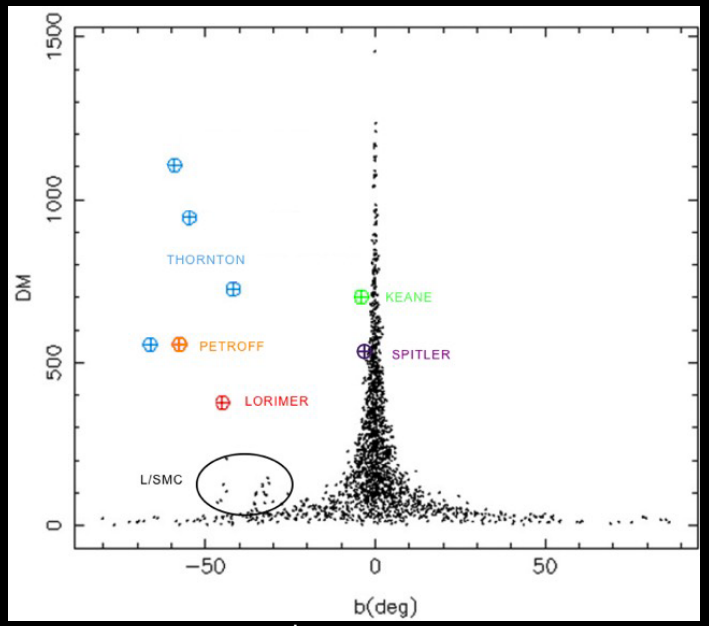
Limit ~1 sec

Pietka, Fender & Keane 2015

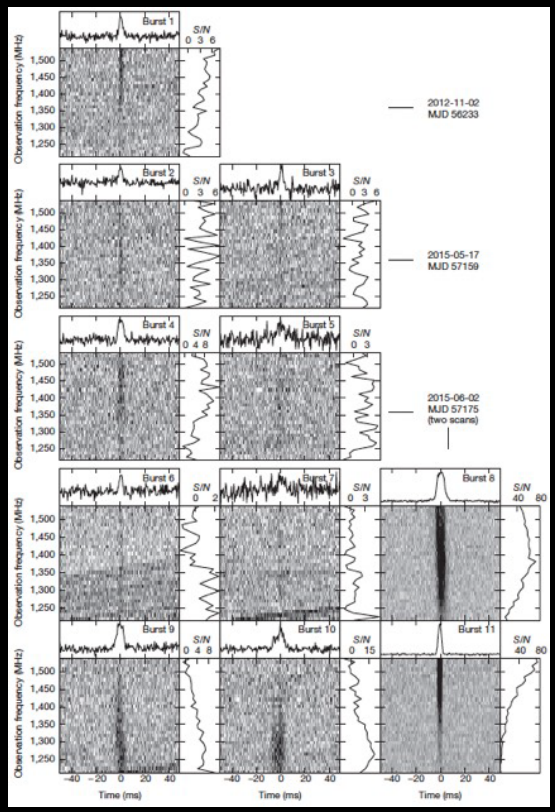
FAST TRANSIENTS: FRB



Lorimer et al. 2007



Ng et al. 2014



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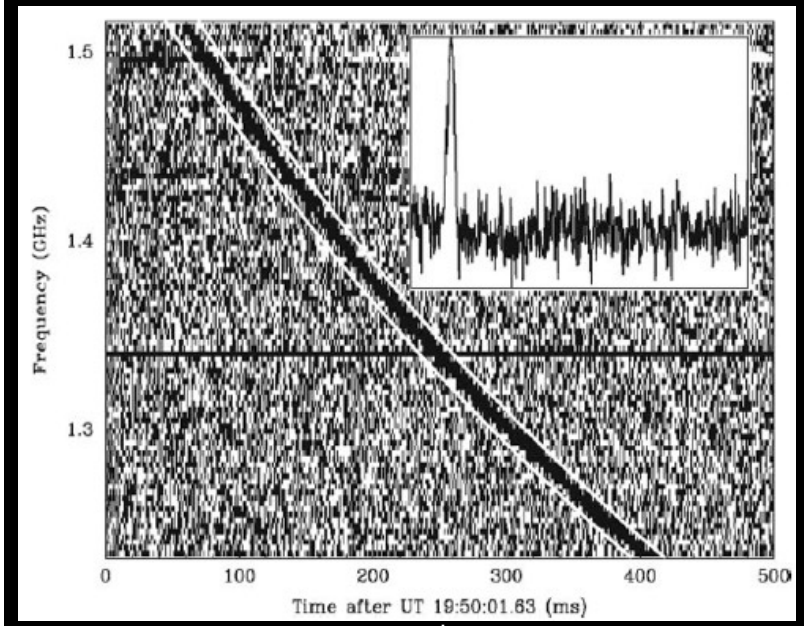

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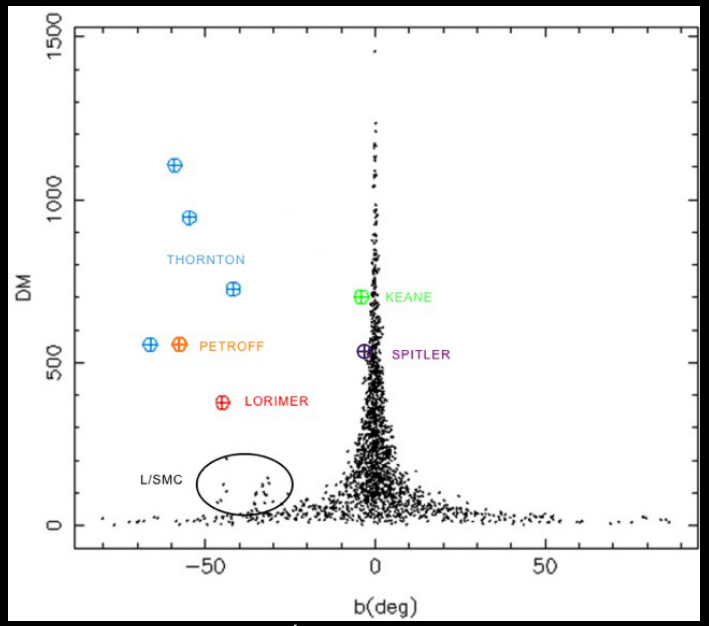

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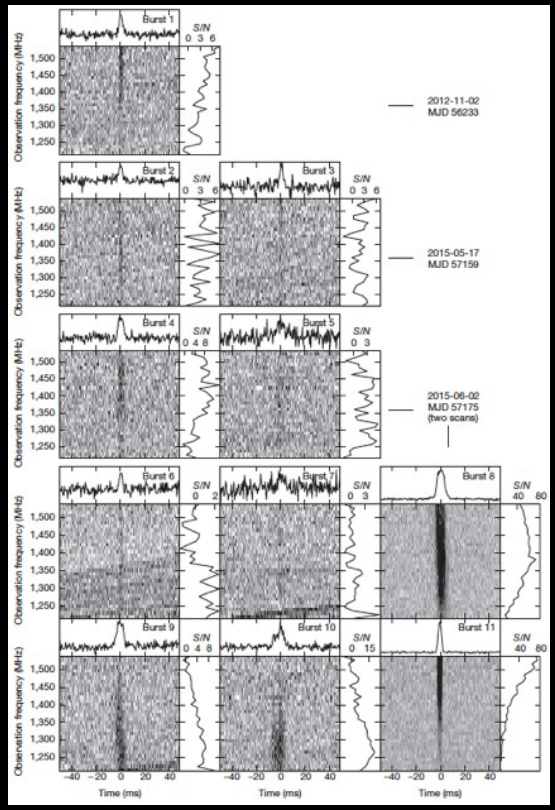

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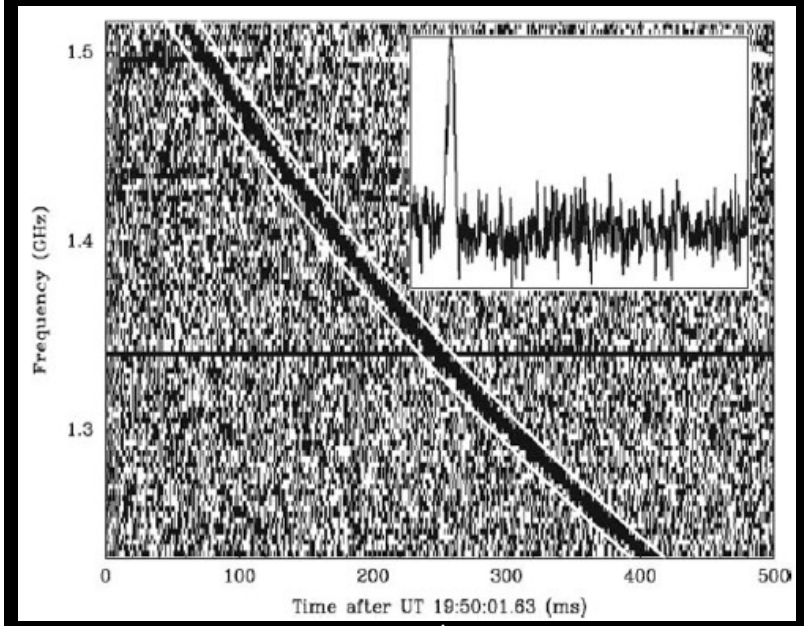

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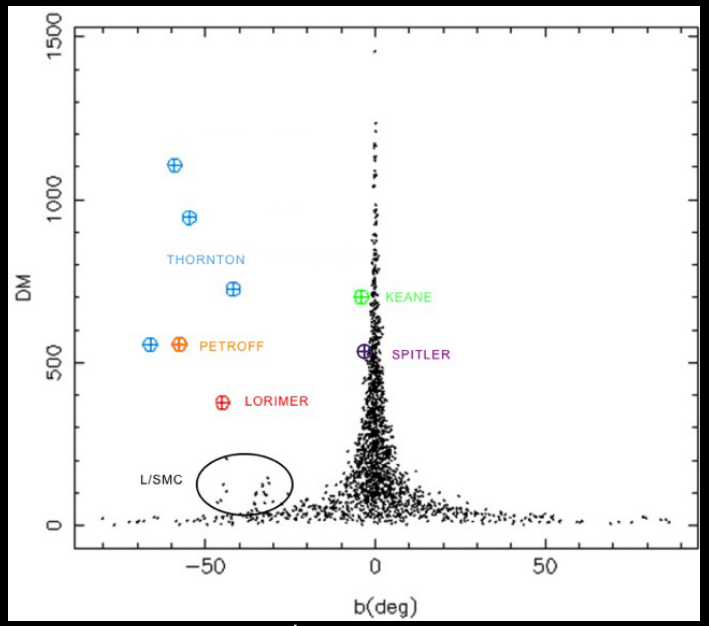

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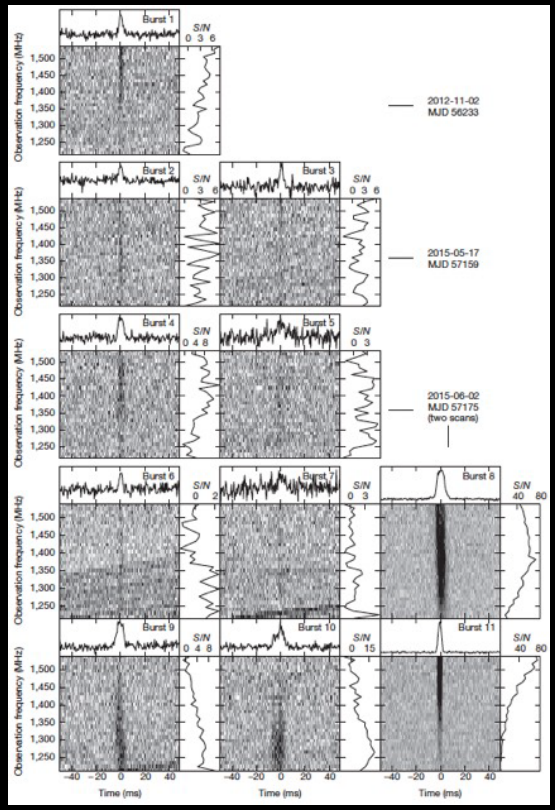

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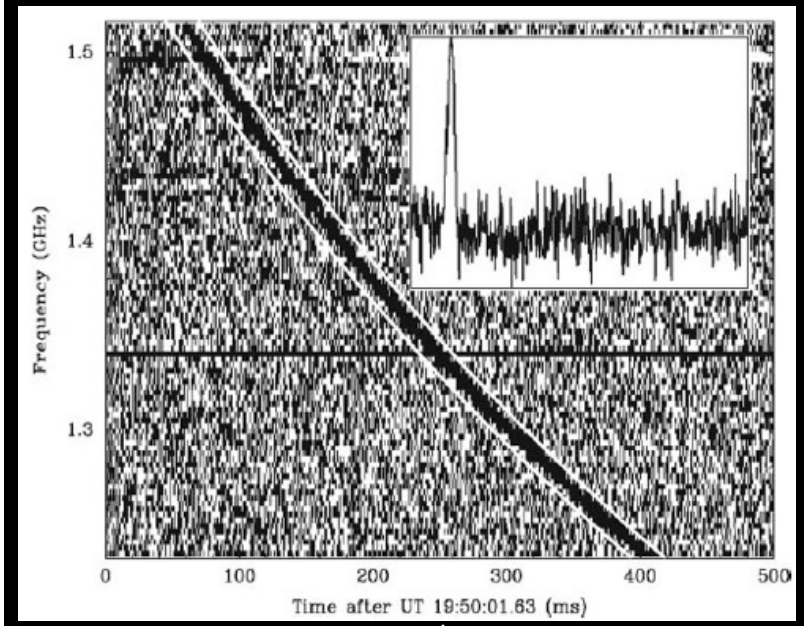

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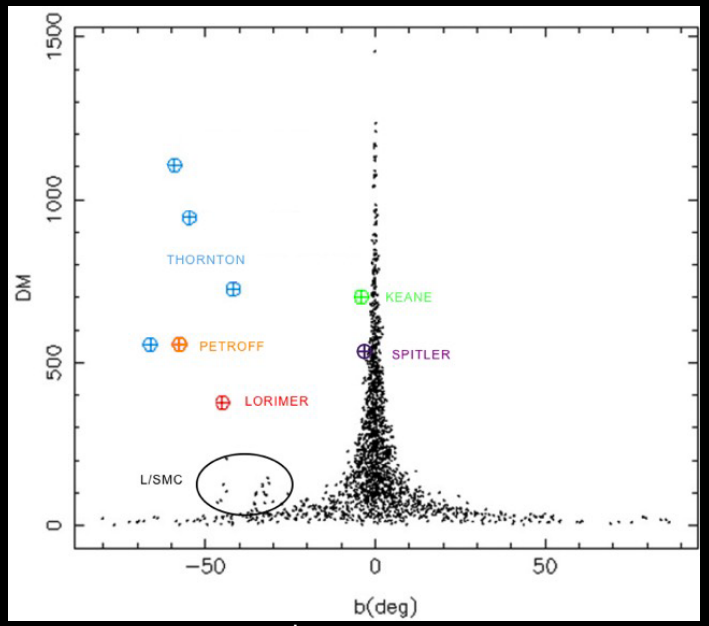

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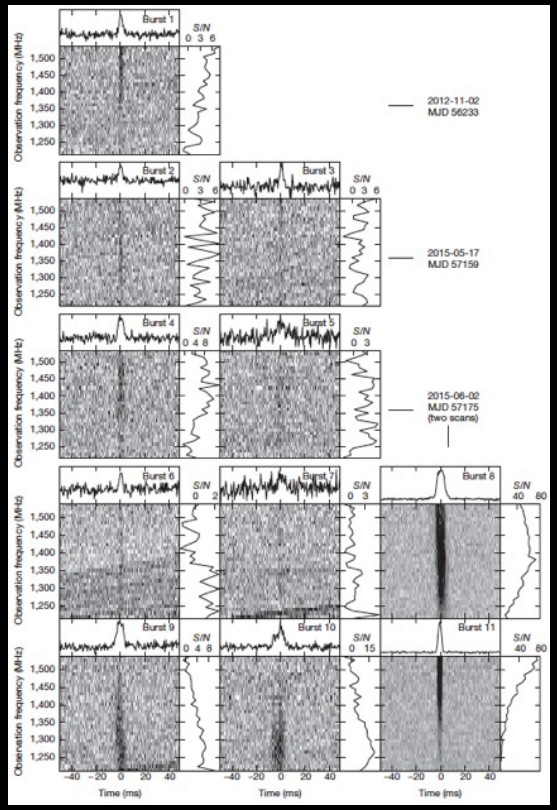

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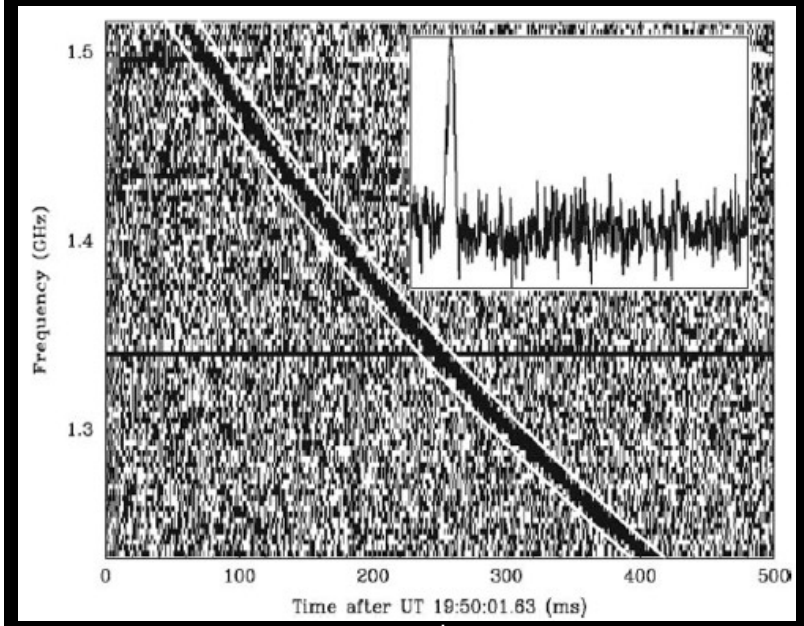

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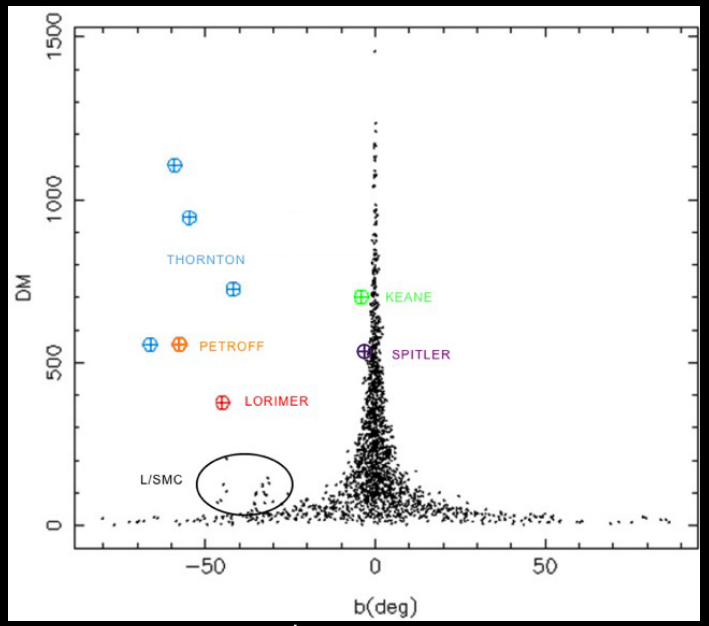

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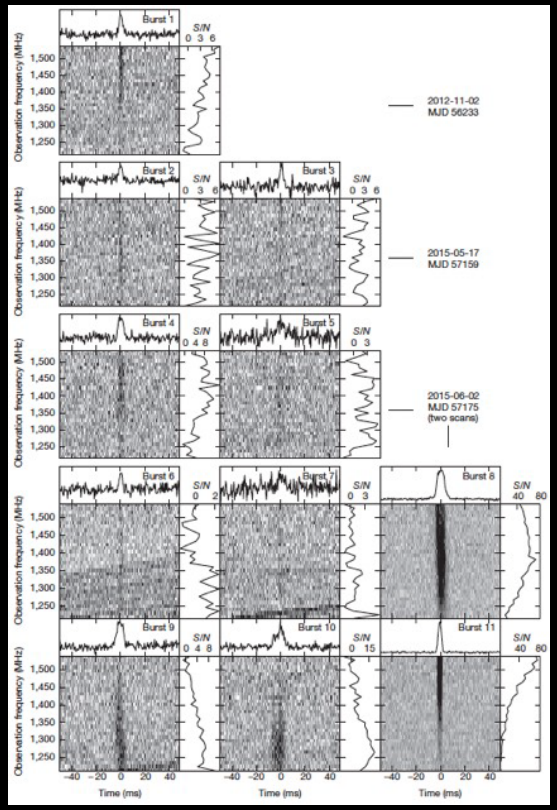

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- Cosmological probes: measuring baryon content (from DM contributions)

MOTIVATIONS FOR SLOW TRANSIENTS

- Accretion: the most powerful source of energy in the Universe !
- Whenever you have accretion, you always see ejection !! Nature of the existing fundamental coupling ? Is it universal along the mass scale ?
- Synchrotron flares from stellar mass compact objects : a unique laboratory with associated variabilities accessible with our lifetime.
- Astrophysics in extreme environments : density, temperature, gravity, velocity, ... !
- Jets: Composition? Formation ? Energetics ? Kinetic feedback on their environment ?
- Existence of intermediate mass black holes ? Seeds of supermassive BHs ? EOR ?

TRANSIENTS & RADIO OBSERVATIONS

- A new generations of radio observatories to probe the variable radio Universe: LOFAR and NenuFAR, MeerKAT, ASKAP, … towards the SKA !
- Advantages of radio observations :
  - Probing the non thermal electrons (similarly to HE telescopes).
  - Large FOV, daily/night; huge sensitivity, precise localis., poss. high resolution imaging, fast reaction time (< 1 min) with response to external triggers.
  - Sometimes coupled with simultaneous multi wavelength observations.
  - Towards the Radio All Sky Monitor and automatic generation of alert by VO events.
  - Transient buffer board (low frequency telescope) —> transient precursors ?

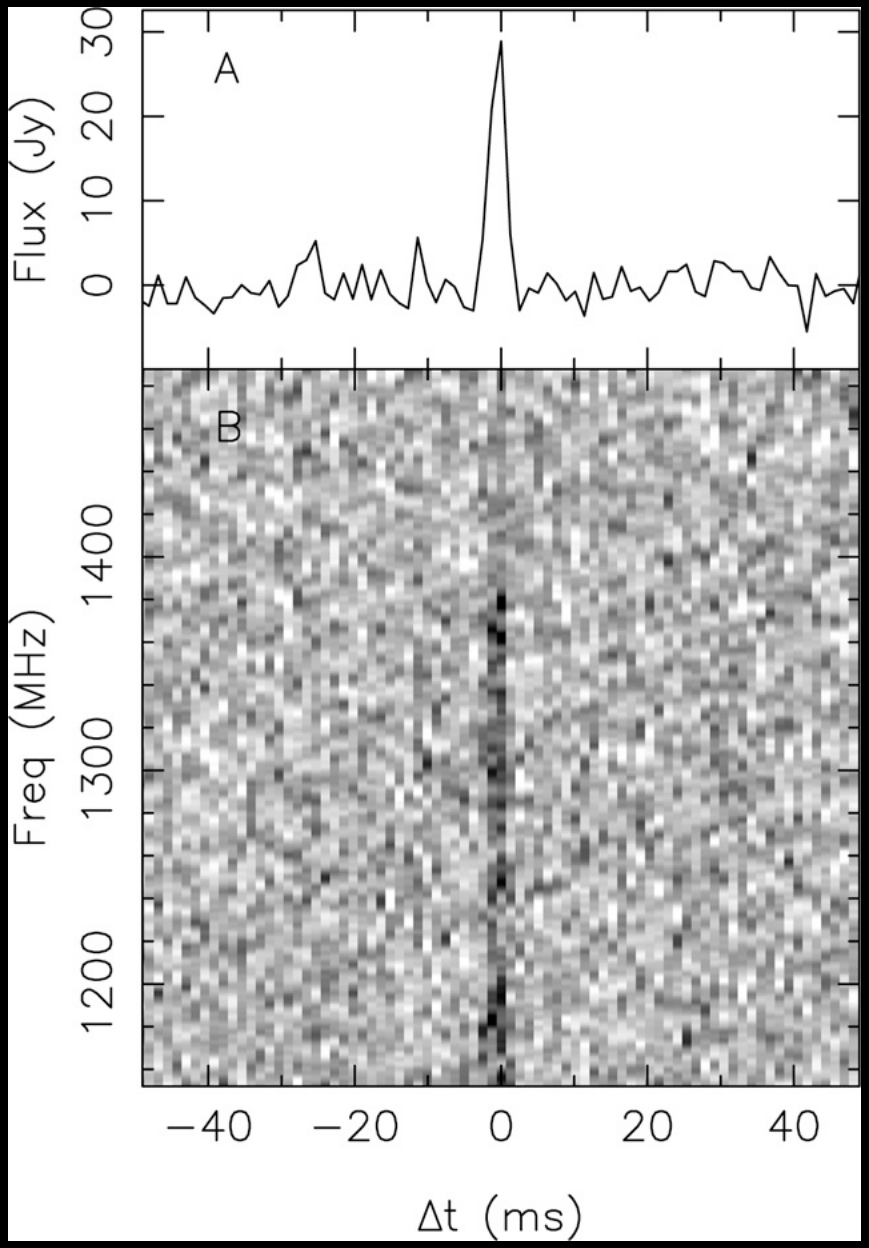
THE SKA PRECURSORS AND PATHFINDERS

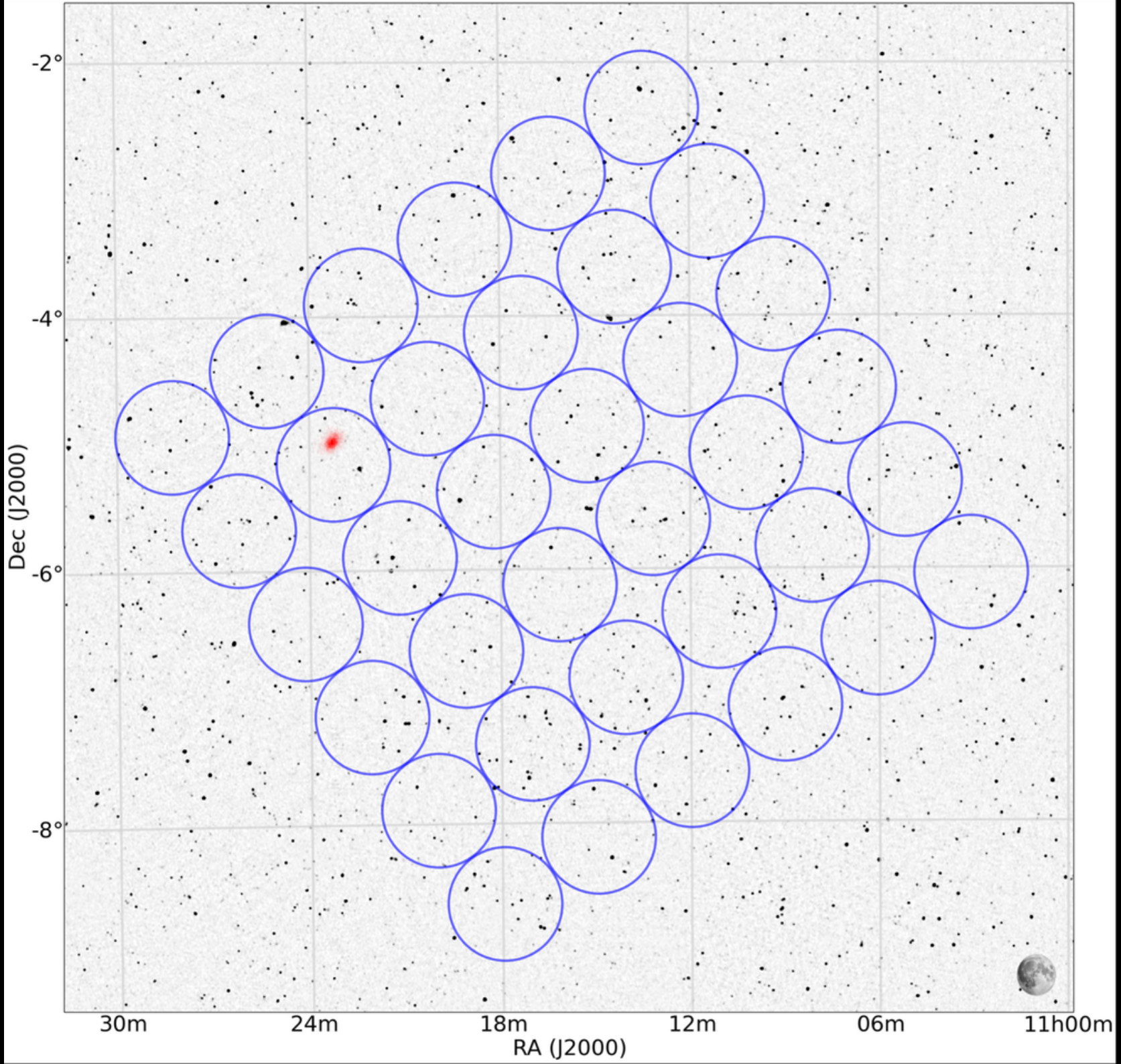
SKA PRECURSORS: ASKAP

- Location: Australia
- Max Baseline : 6 km
- Frequency coverage: 0.7-1.8 GHz
- 36 antennas (12 m) with PAF (30 deg^2 FOV)
- Fully operational, all antennas equipped with PAF

FIRST ASKAP FRB IN MAY 2017!

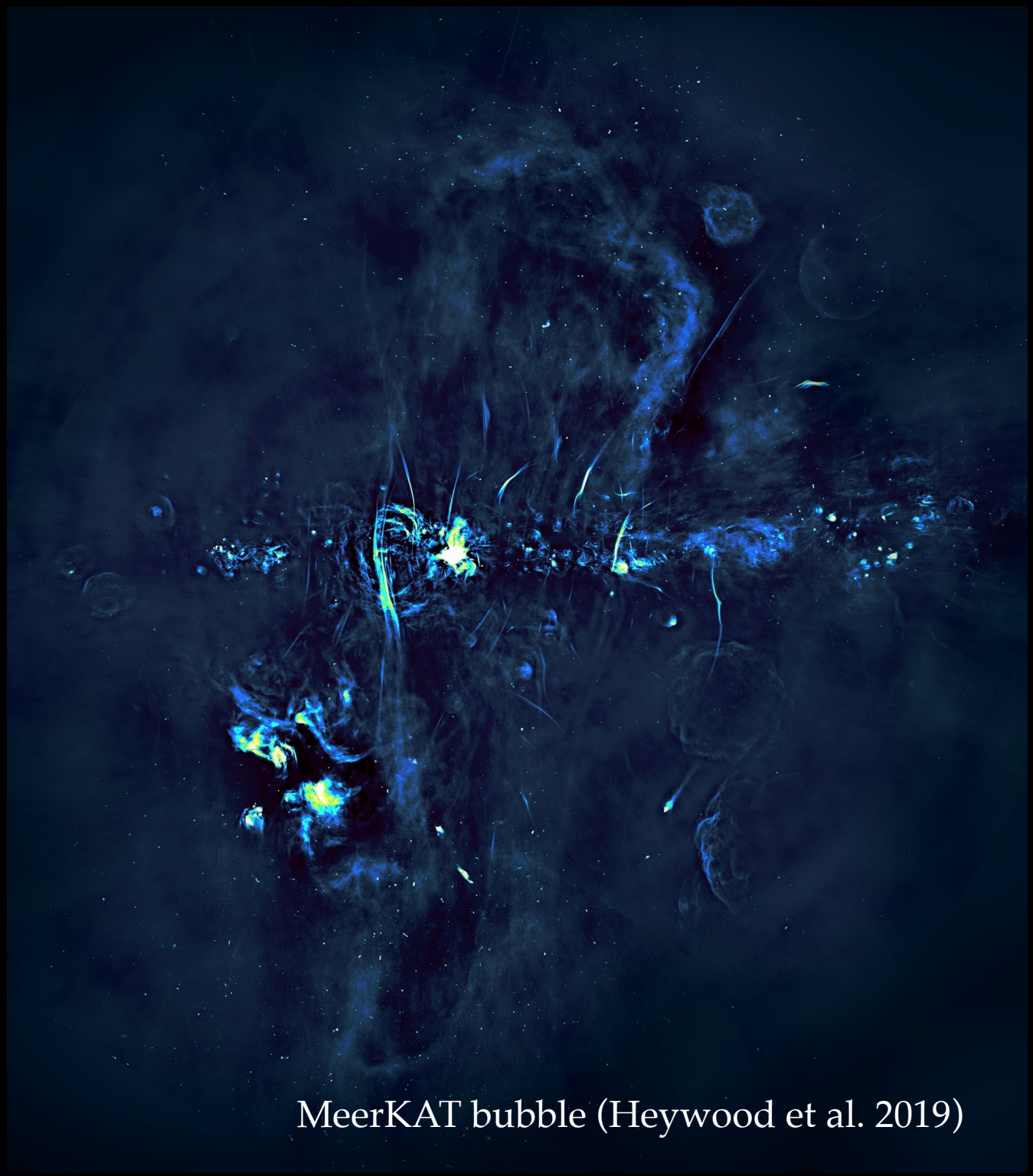
« ASKAP has found its first FRB after less than four days of searching (8 antennas). The discovery came so quickly that the telescope looks set to become a world champion in this fiercely competitive area of astronomy. » ASKAP press release. CRAFT




-2°
-4°
-6°
-8°
Dec (J2000)
30m
24m
18m
12m
06m
11h00m
RA (J2000)

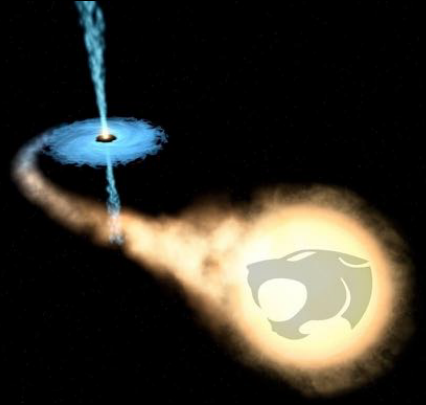
SKA PRECURSORS: MEERKAT

- Location: South Africa
- 64 antennas (13.5 m) over an 8-km baseline
- Frequency coverage: 0.5-10 GHz (now L-band (0.9–1.67 GHz), UHF (0.58–1.0 GHz) : 56 active antennas, S-band (1.75–3.5 GHz – by MPIfR) to come.
- Expanded MeerKAT+20 15-m dishes, baseline up to 18 km
- FOV: 1.69 deg^2 @ 1 GHz
- Inauguration in July 2018. Observations continue for MeerTime, ThunderKAT, MIGHTEE, and Open Time projects



MeerKAT bubble (Heywood et al. 2019)

THUNDERKAT
(PI: FENDER/WOUDT)

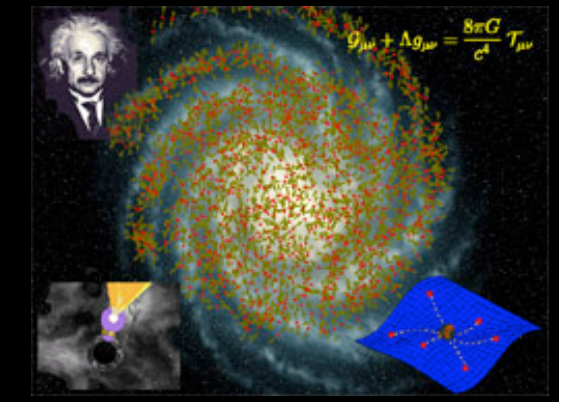


A MeerKAT Large Survey Project for synchrotron radio transients

- **Survey** and **monitor** populations of Galactic and extragalactic **synchrotron radio transients** (CVs, GRBs, XRBs, SN 1a).
- **Commensal** observations + **pointed** observations (3000 h = 100 min/day) typically for follow-up + simultaneous optical observations with **MeerLicht**.
- **Large international collaboration** (56 co-Is from 9 countries): AIM, IAP, IRAP, GEPI

- All the slides related to the preliminary results from the the ThunderKAT collaboration can not be put online.
- See later :
  - Tremou et al. (for GX 339-4),
  - Coriat et al. (Cir X-1),
  - Espinasse et al. (for MAXI J1820+070),
  - Carotenuto et al. (for MAXI1348-630).

CONCLUSIONS



- Deployment of ASKAP and MeerKAT is done.
- MeerKAP still to be upgraded with 20 more antennae (D) and new receivers for higher frequencies
- NenuFAR is building up, Early Science. See PZ's talk.
- First results from ASKAP and MeerKAT start to be available
- Strong synergies (not discussed here)
- Large programs to be discussed later : see
  - https://www.atnf.csiro.au/projects/askap/science.html
  - https://www.ska.ac.za/science-engineering/meerkat/observers/observing-programme/large-survey-projects/