

A Ground Experimental Approach Toward Understanding Mysterious Astrophysical Fast Radio Bursts



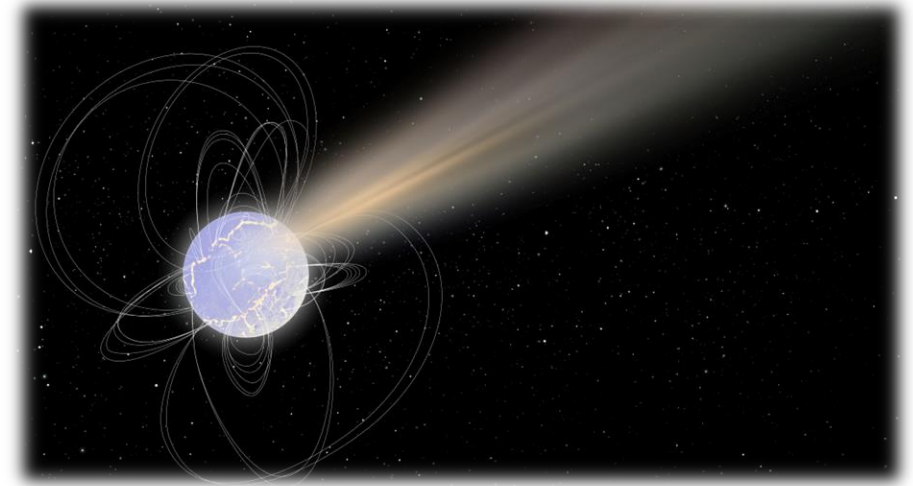
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Motivation: Astrophysical Fast Radio Bursts

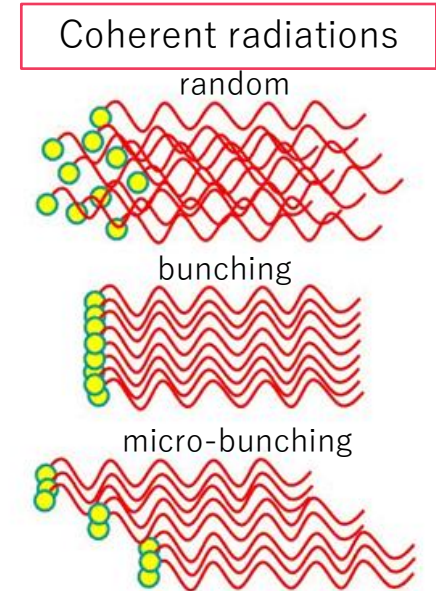
- Recent mysterious RF burst signals
 - Discovered initially in 2007, blooming since 2013.
[Lorimer et al., Science 318, 777 (2007)], [Thornton et.al., Science 341, 53 (2013)]
 - Recent rapid developments.
- Some characteristics
 - RF short burst signals with milliseconds durations.
 - A class of brightest events ever observed.
 - Some repetitive, but mostly sudden events.
 - Observations suggest the existence of abundant plasma fields around parent bodies.
 - **Basic mechanism not yet understood.** e.g. [Nature News, Nature 582, 344 (2020)]
Difficult to explain in the conventional sense. **Need a new idea.**



Artist's impression of SGR 1935+2154 © ESA

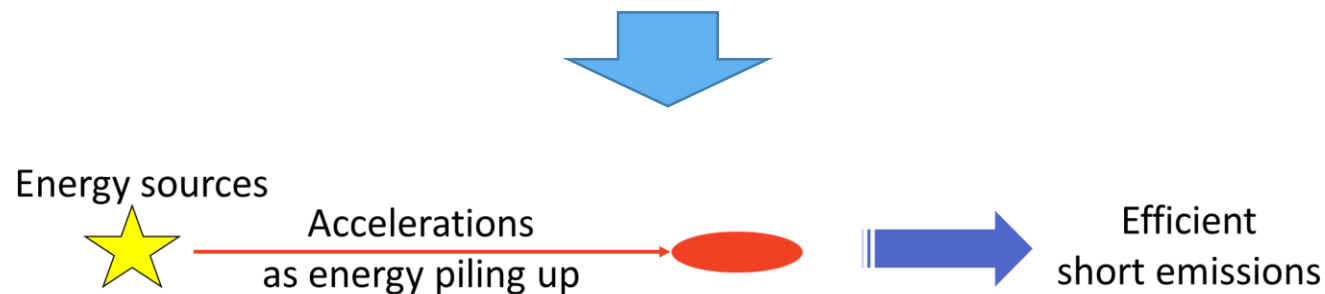
A challenge from ground experiments with some keys

- Key 1: Accelerated **relativistic particles** are ubiquitous in space.
 - Evidence of existence of PeV accelerations.
[Amenomori et al., Phys. Rev. Lett. 126, 141101 (2021)] [Cao et al., Nature 594, 33–36 (2021)]
 - Not difficult to expect high current beams.
- Key 2: Accelerator knowledge of **collective motions** may help?
 - We are familiar with some **non-linearly enhanced emissions**.

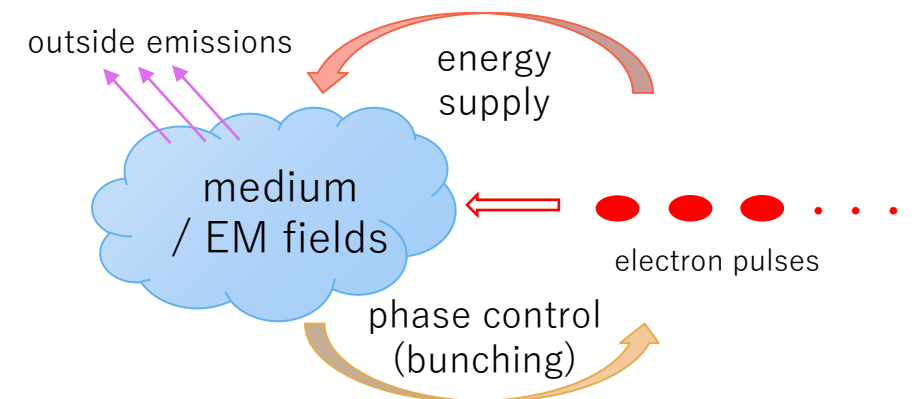


From Institute for Molecular Science web

Integrated interactions
(e.g. oscillator FEL)



A hint for short duration burst events



Toward Fast Radio Bursts on ground

➤ Missing part: **plasma fields**

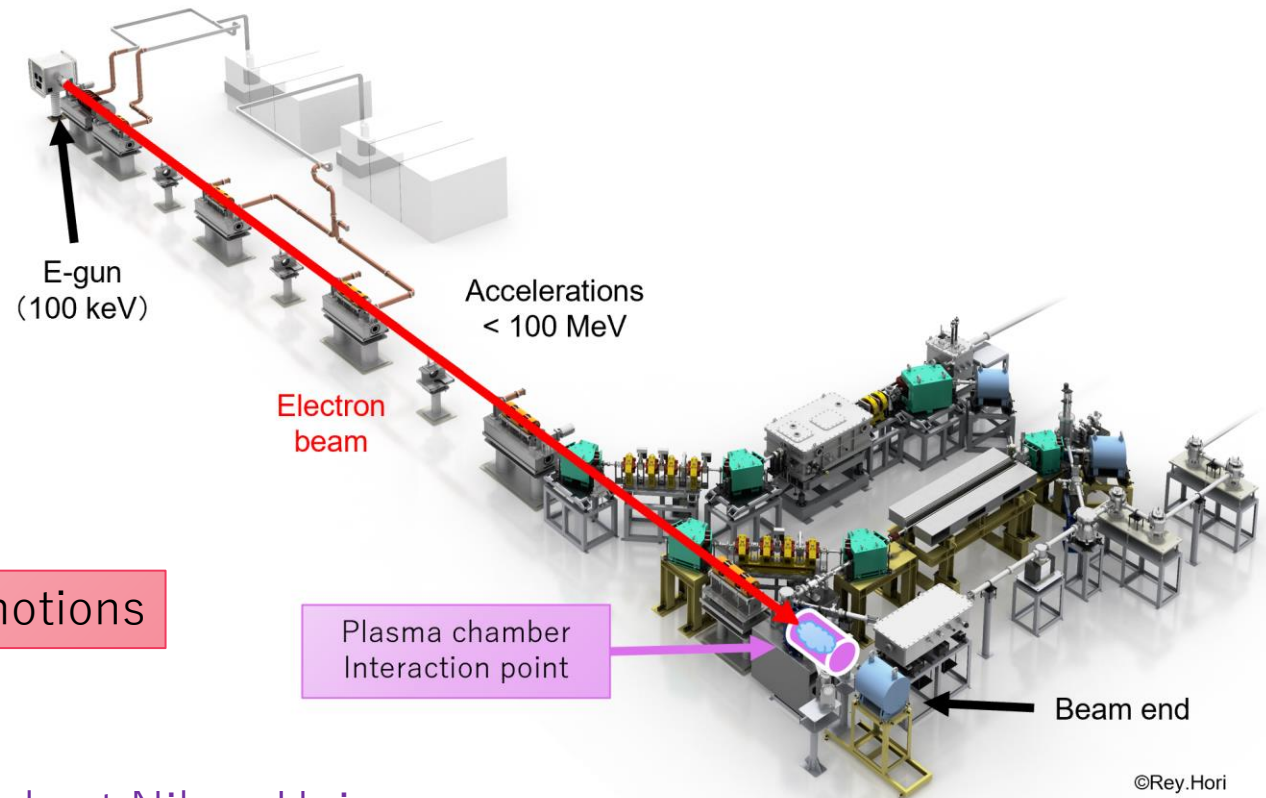
- Mimicking plasmas in space

Plasma beta = $\frac{\text{thermal pressure}}{\text{magnetic pressure}} \sim 1$,
same order in space.

- Aiming for **integrated collective interactions**:

plasma modulation

e-beam collective motions



➤ Advantage: ingredients and knowledge are ready at Nihon Univ.

- **Accelerator side**: suitable for relativistic integrated collective interactions (100 MeV, 50k bunches).
- **Plasma side**: mature experience of plasma generations with the similar property in space.