The Mysterious Radio Signal: *An Unnatural Phenomenon?*

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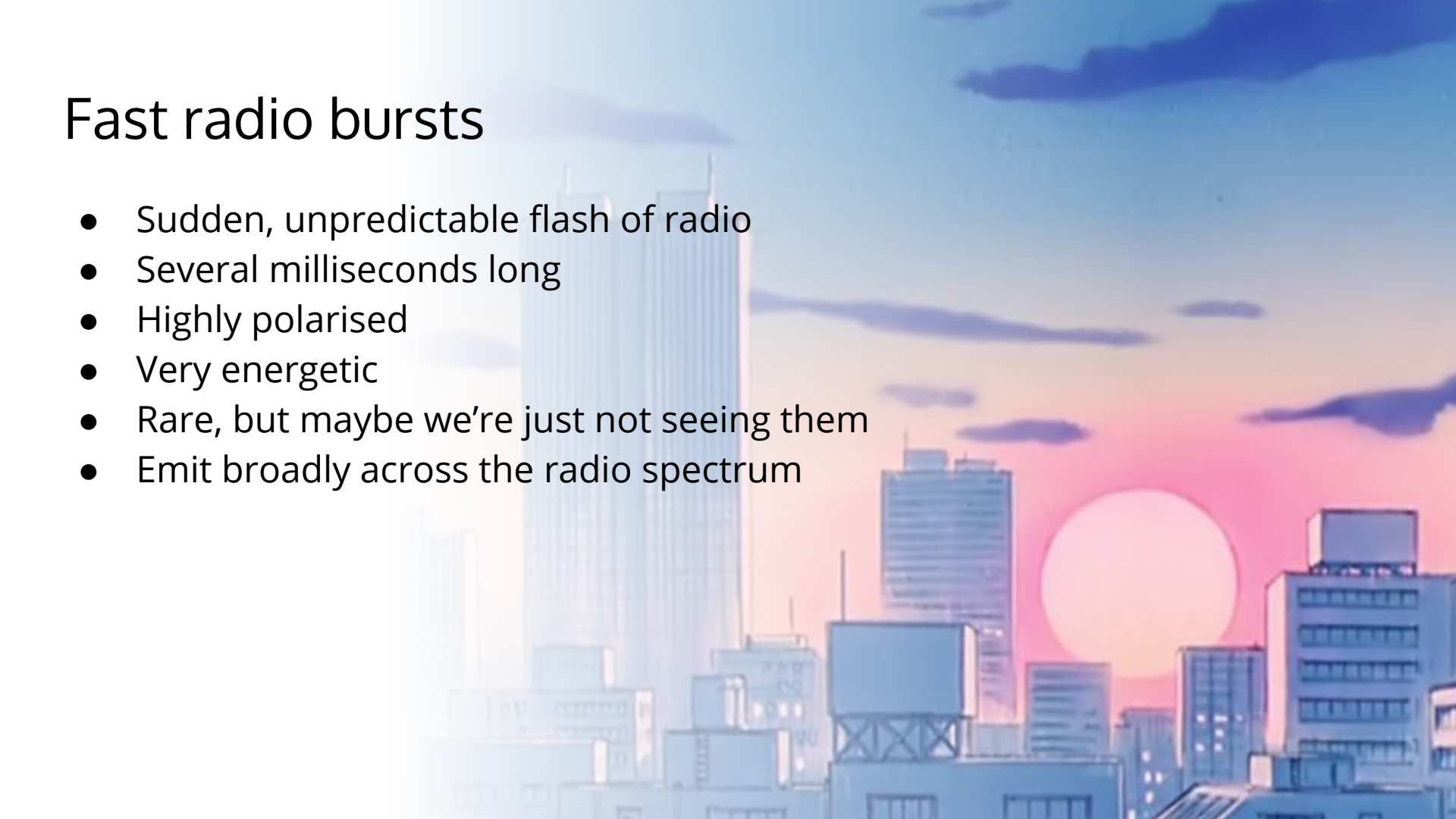
Slides: http://www.mso.anu.edu.au/~alger/mso-xmas-18

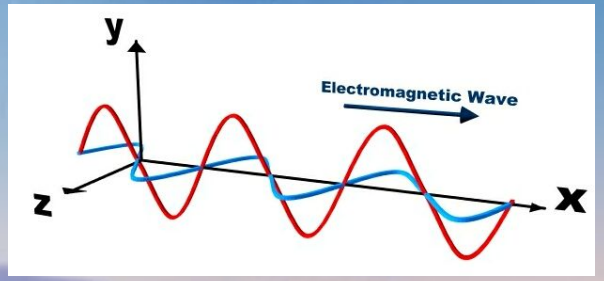
Fast radio bursts

- Sudden, unpredictable flash of radio
- Several milliseconds long
- Highly polarised
- Very energetic
- Rare, but maybe we’re just not seeing them
- Emit broadly across the radio spectrum



Motivation?

- Radio waves = **electromagnetic** waves
  - Electric field and magnetic field at right angles



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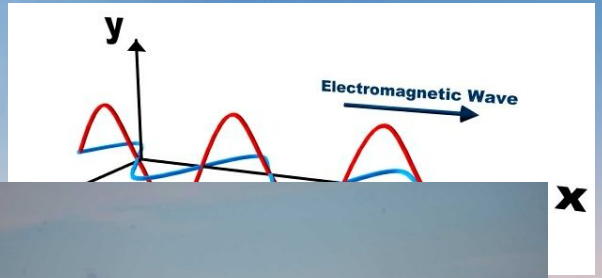
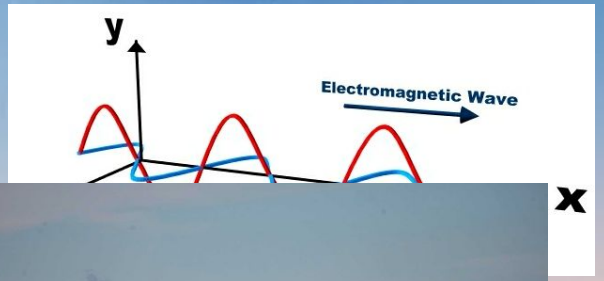
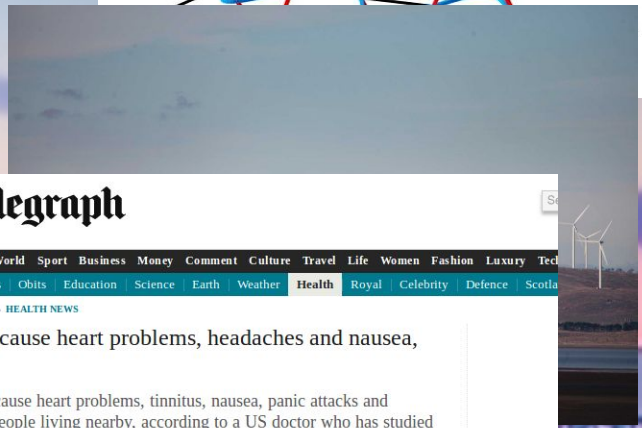


Motivation?

- Radio waves = **electromagnetic** waves
  - Electric field and magnetic field at right angles
- Electric fields are made by **wind turbines**
- Wind turbines give people **migraines**





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Wind turbines cause heart problems, headaches and nausea, claims doctor

Wind turbines can cause heart problems, tinnitus, nausea, panic attacks and headaches among people living nearby, according to a US doctor who has studied their effects for five years.

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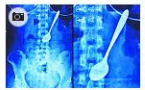


Weird X-rays

Potential causes

- Neutron star collisions?
- Active galactic nuclei?
- **Extraterrestrial life?**

The Kepler mission

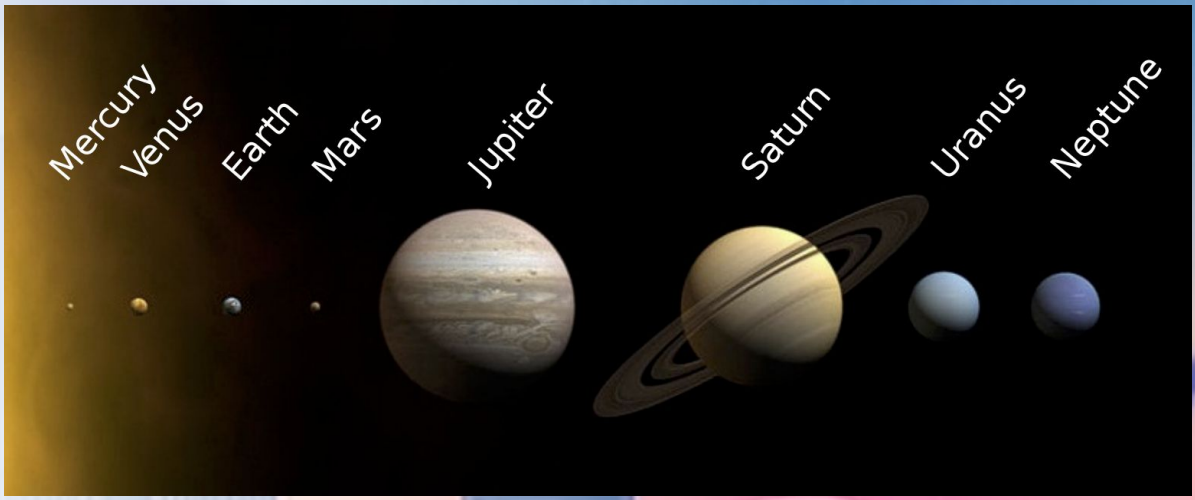
- Named after Johannes Kepler (right)
- Intended to discover Earth-size, habitable planets around other stars
- Discovered 2,662 exoplanets from a survey of 530,506 stars

- At least how many solar systems contain planets?
  - $2662/530506 \approx 0.5\%$
  - $250{,}000{,}000{,}000$ stars × 0.5% = $1{,}250{,}000{,}000+$ planets

Image: Honkai Impact

Our solar system

- One 1$M_{\odot}$ star
- 8 planets
- Many dwarf planets



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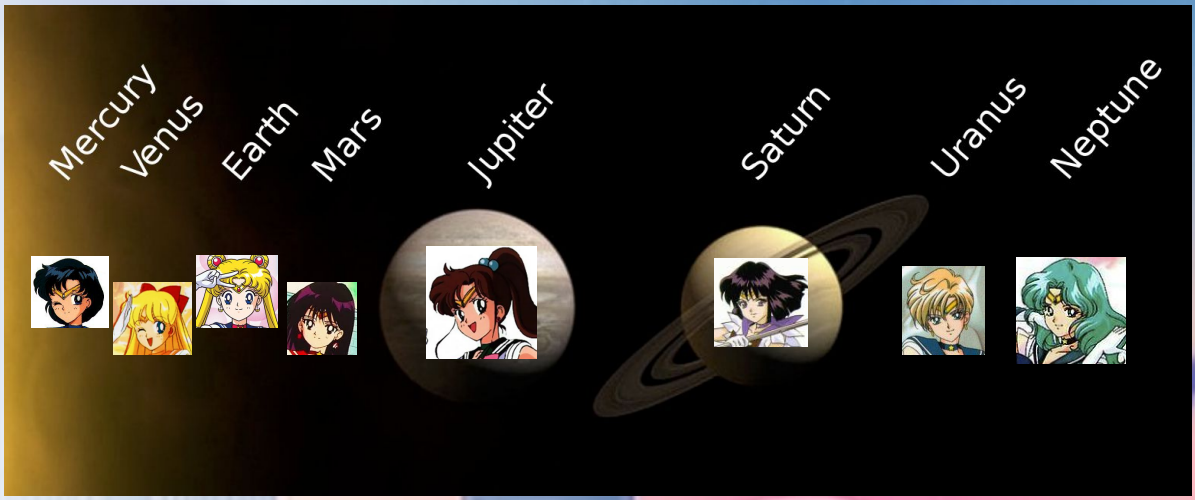
- Many dwarf planets
- >8 Sailor Scouts
  - One per planet



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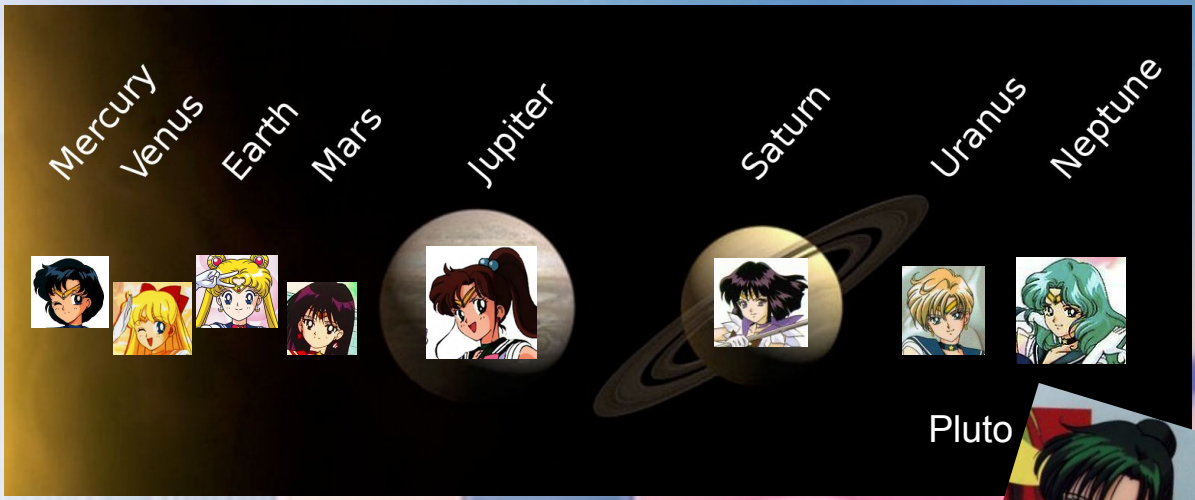
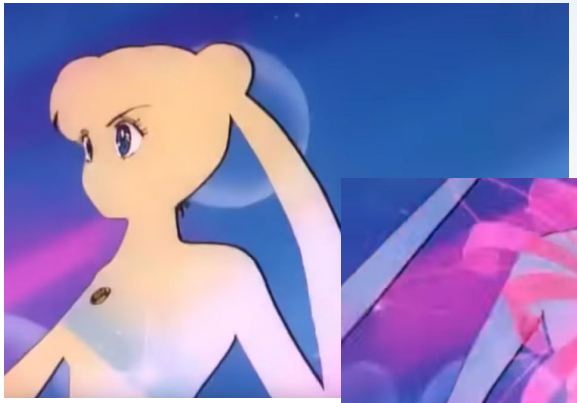


- 1,250,000,000 planets
- ⇒ 1,250,000,000+ Sailor Scouts
- We call these **exosailor scouts**

A galaxy of Sailor Scouts?

Magical girl main sequence



Could exosailor scouts cause fast radio bursts?

- Some links are obvious…
  - Sudden, unpredictable flash of radio = **sudden** activation sequence
  - Several milliseconds long = short time to activate for **bad-guy fighting**
- Some are less so:
  - Highly polarised
  - Very energetic
  - Rare, but maybe we’re just not seeing them
  - Emit broadly across the radio spectrum

Observed magnetic field lines

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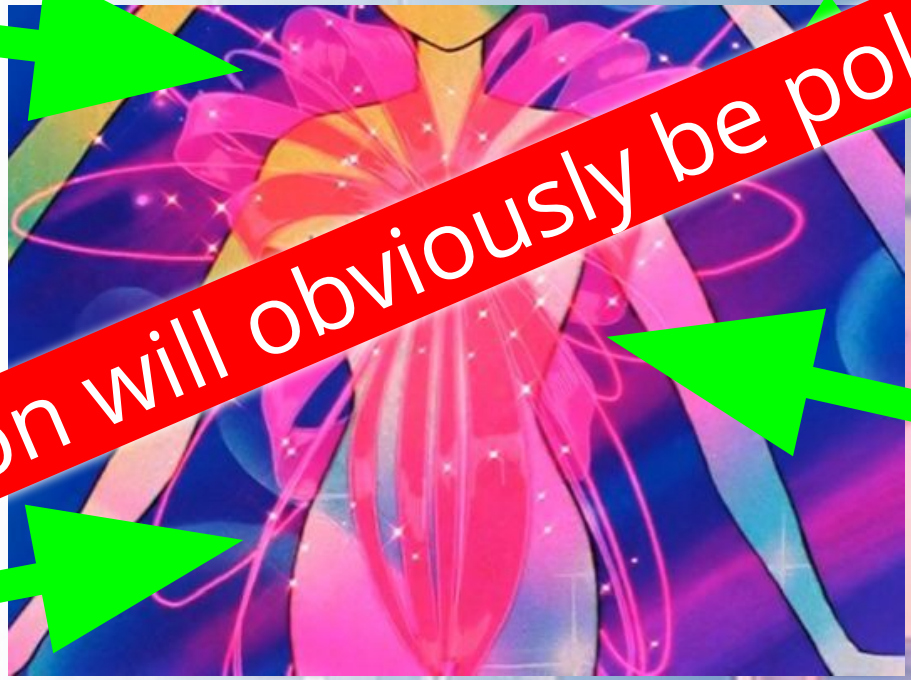
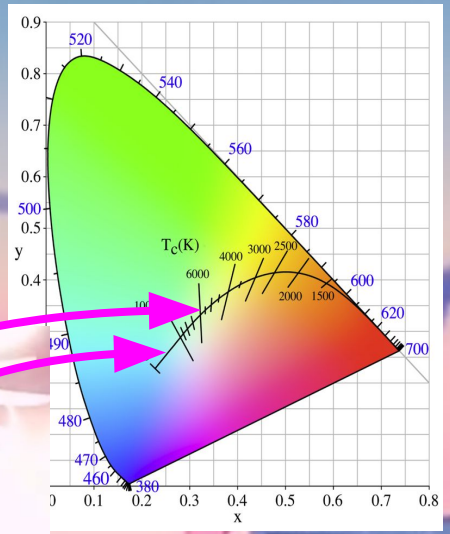


Emission will obviously be polarised!

Luminosity of Sailor Scouts

- Assume Sailor Scouts are **perfect blackbodies**
- Colour temperature in excess of **6000 K**
- Stefan-Boltzmann law: $P = A\sigma T^4$
  - $L_{\text{Sailor Scout}} = 1.6\ m^2 \times 5.67 \times 10^{-8}\ W\ m^{-2}\ K^{-4} \times (6000\ K)^4$
  - $= 1.1758073 \times 10^8\ W$
- Account for time dilation
  - Assume activation sequence takes 5 ms
  - This corresponds to proper time of 50 s
  - $t' = \gamma t \Rightarrow \gamma = 10000$ — highly relativistic!
- Relativistic beaming
  - $\delta = (\gamma - \cos\theta\ (\gamma^2 - 1)^{1/2})^{-1}$
  - $L_{\text{Sailor Scout, observed}} = \delta^{3+\alpha} L_{\text{Sailor Scout}}$



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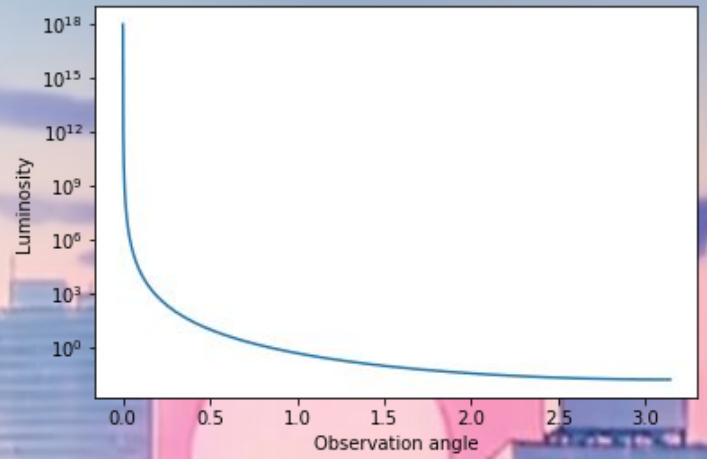

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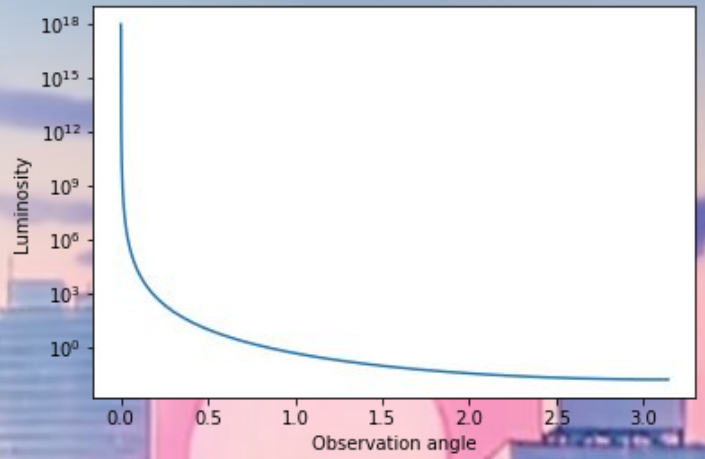
- Brightness falls off with inverse-square law
  - $B_{\text{Sailor Scout, observed}} = \delta^{3+\alpha} L_{\text{Sailor Scout}} / 4\pi D^2$
  - Assume **non-cosmological distances**
  - Alpha Centauri $D = 4.132 \times 10^{16}$ m
  - Too faint!



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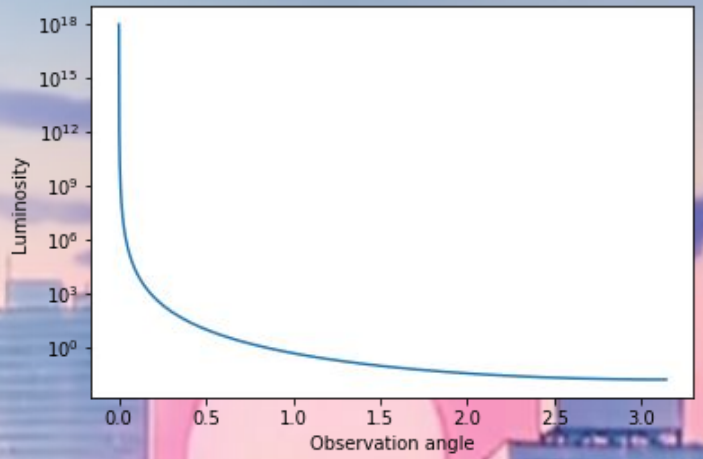

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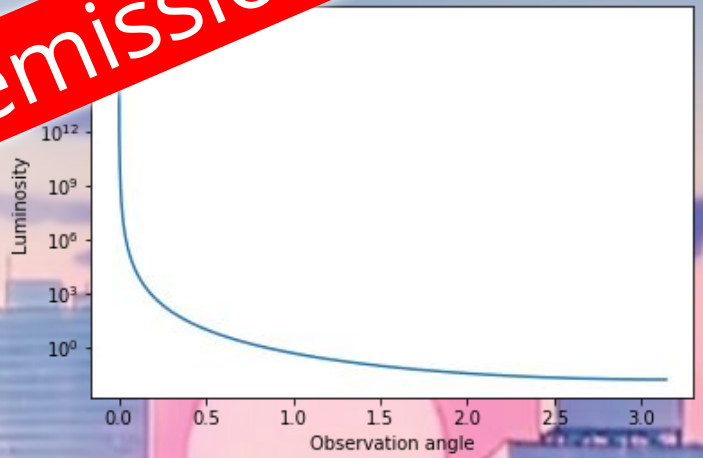
Non-blackbody emission!



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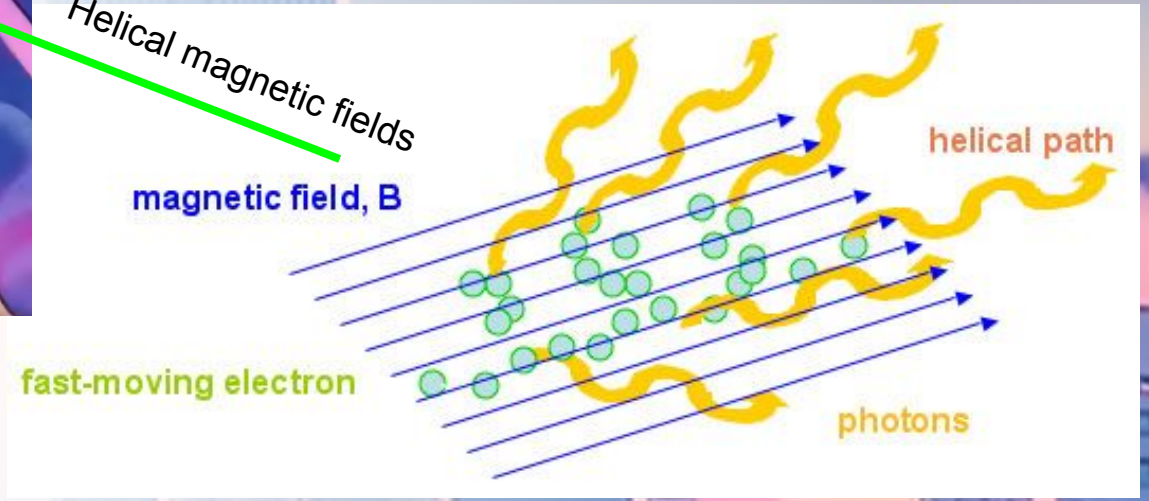
Synchrotron emission from exosailor scouts



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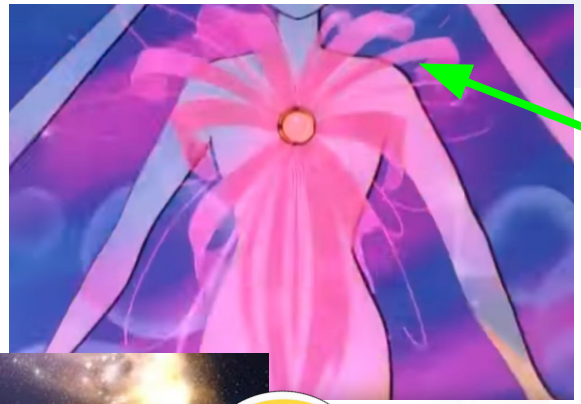

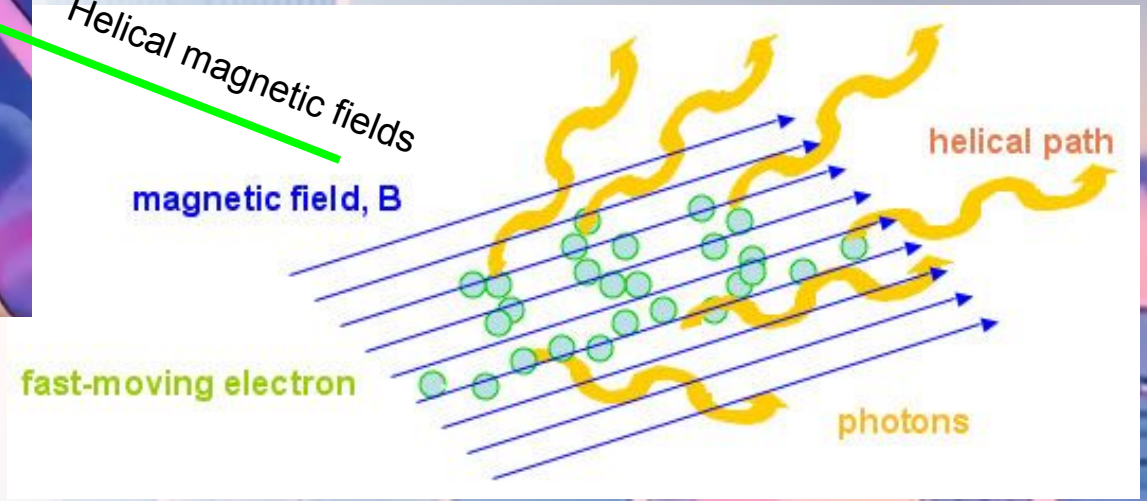

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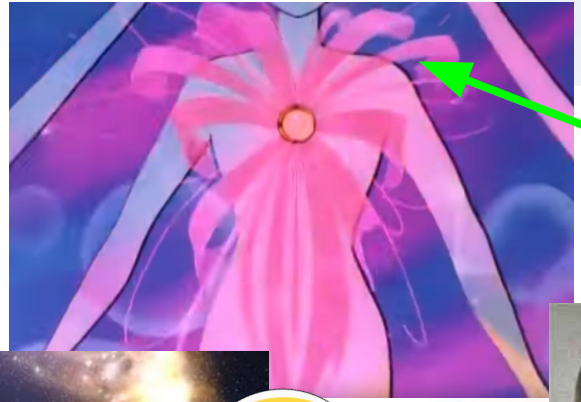

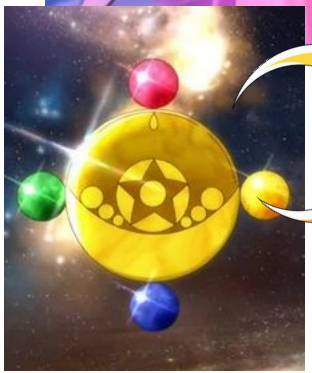

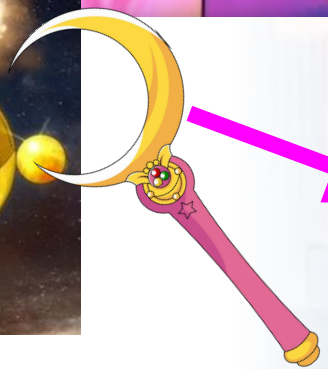

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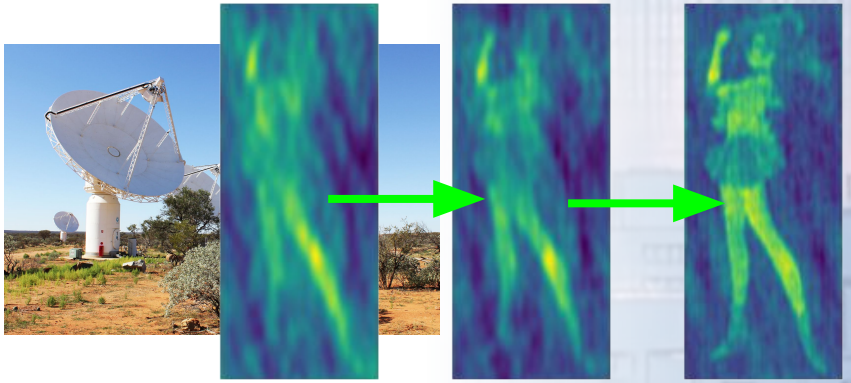

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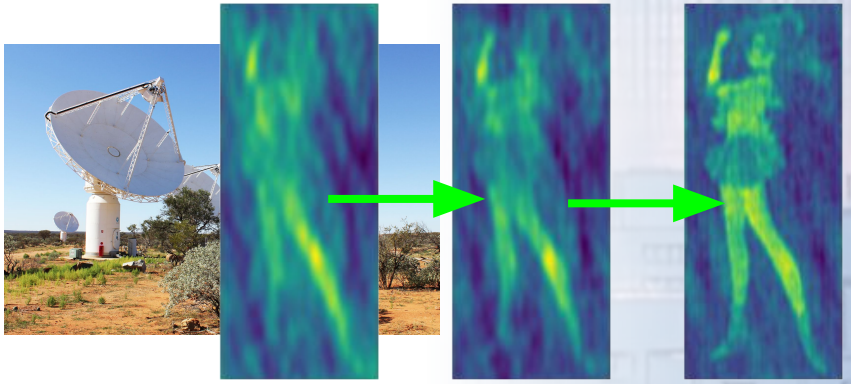
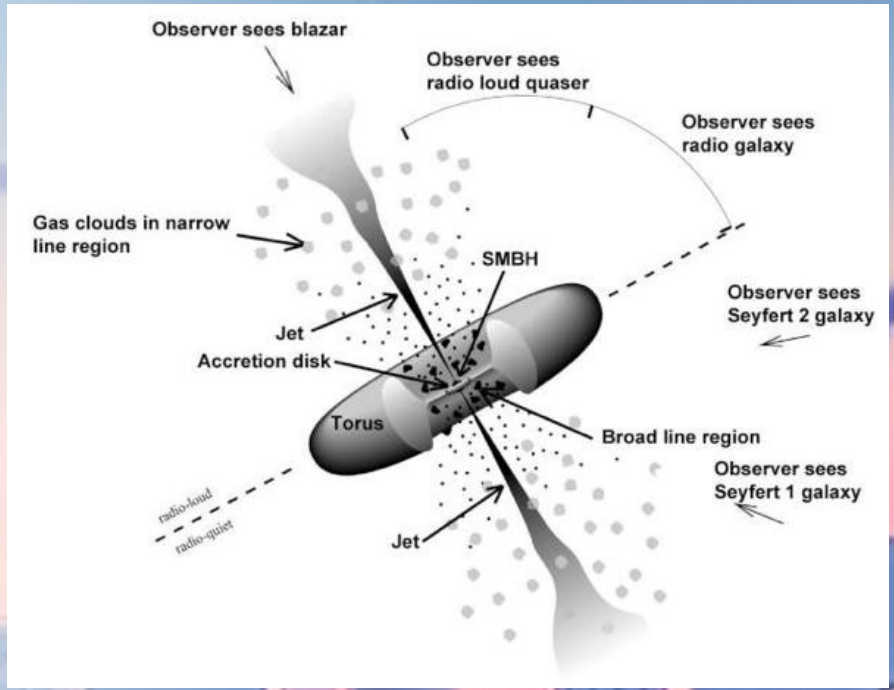
- **Unified model** of magical girls?





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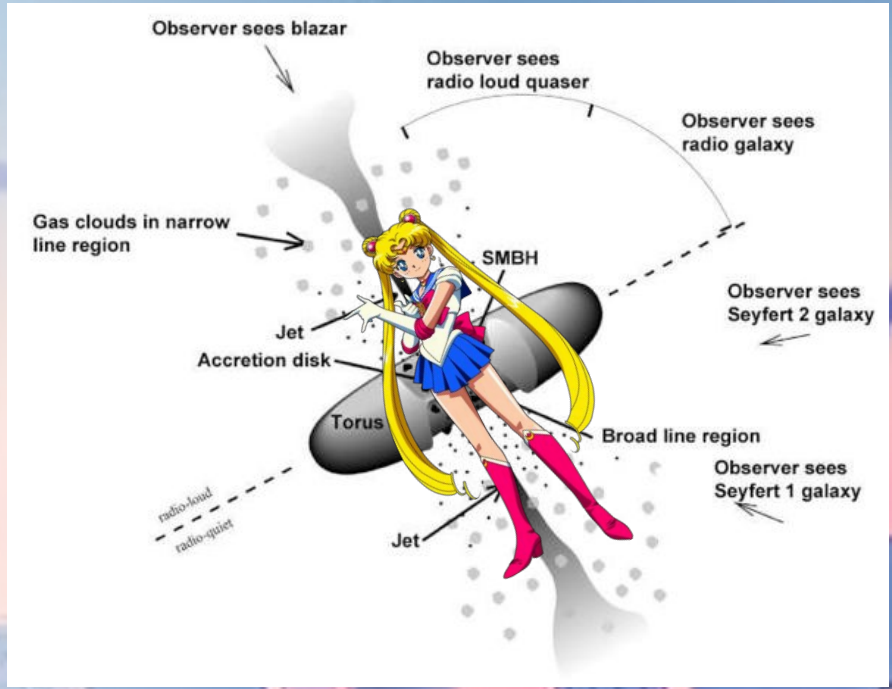

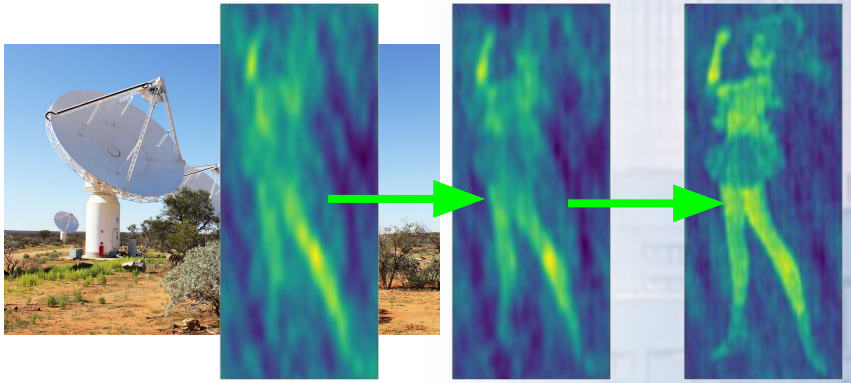

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- Direct, **multi-messenger** detection