

The Mysterious Radio Signal: *An Unnatural Phenomenon?*

Matthew Alger (ANU/Data61)

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



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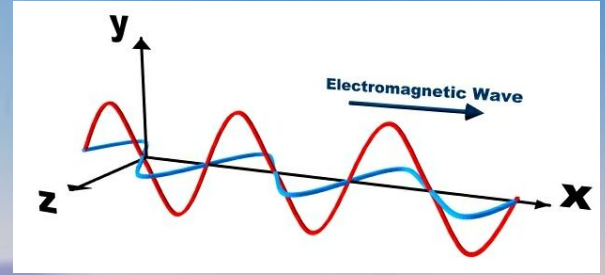
Fast radio bursts

- 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



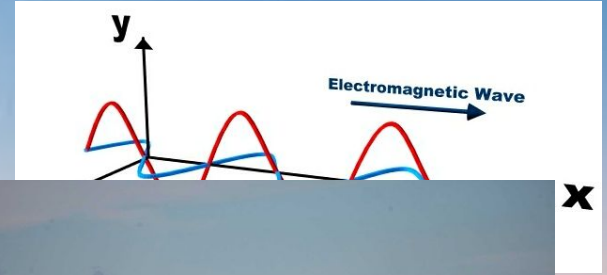
Motivation?

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



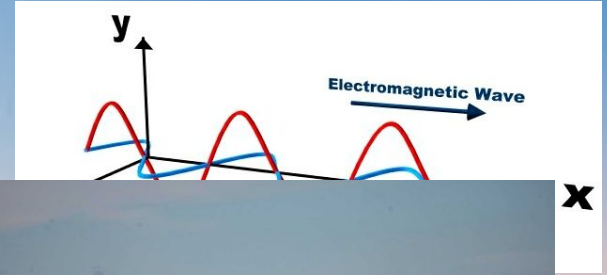
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Motivation?

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



Potential causes

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



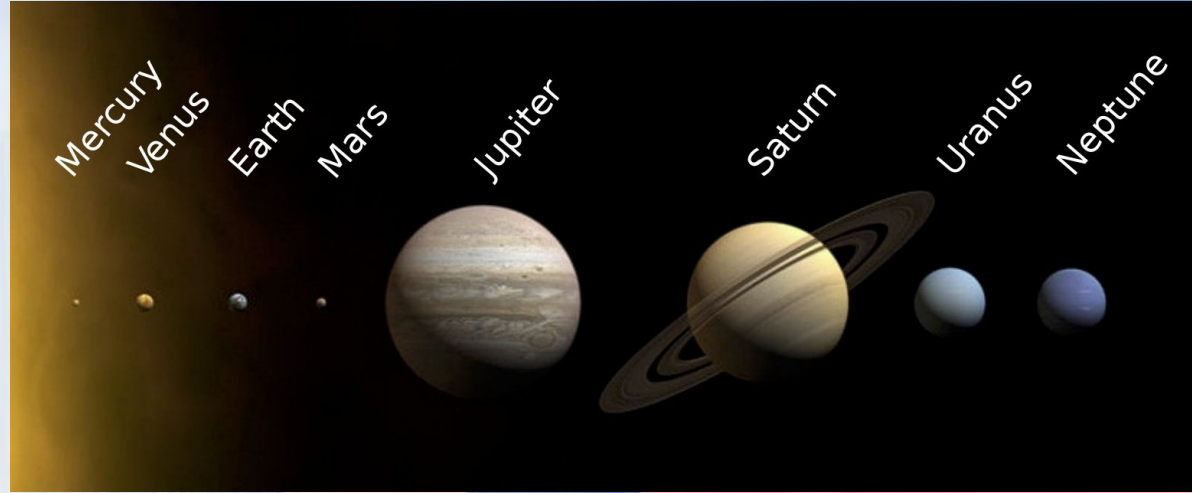
The Kepler mission

- 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?
 - $2662/530506 \approx 0.5\%$
 - $250,000,000,000 \text{ stars} \times 0.5\% = 1,250,000,000+ \text{ planets}$



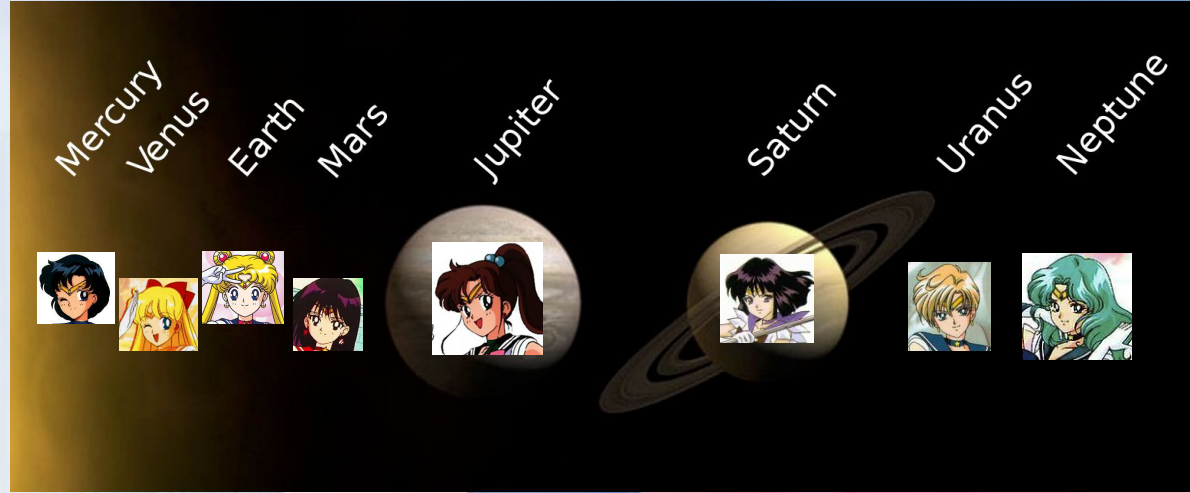
Our solar system

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



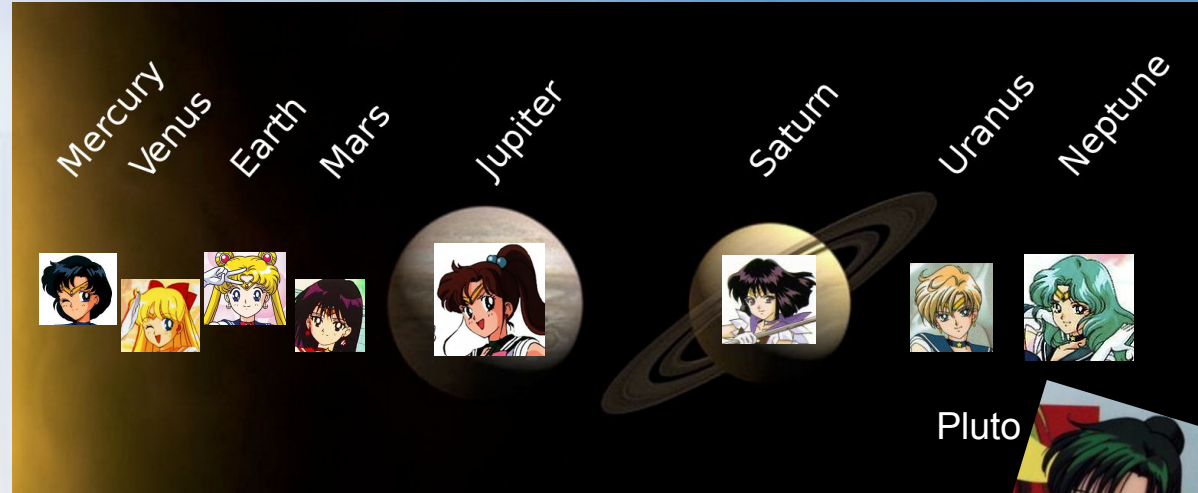
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- >8 Sailor Scouts
 - One per planet



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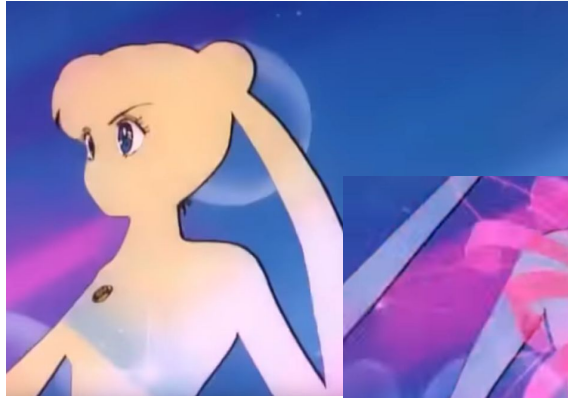




- 1,250,000,000 planets
- \Rightarrow 1,250,000,000+ Sailor Scouts
- We call these **exosailor scouts**

A galaxy of Sailor Scouts?

Magical girl main sequence

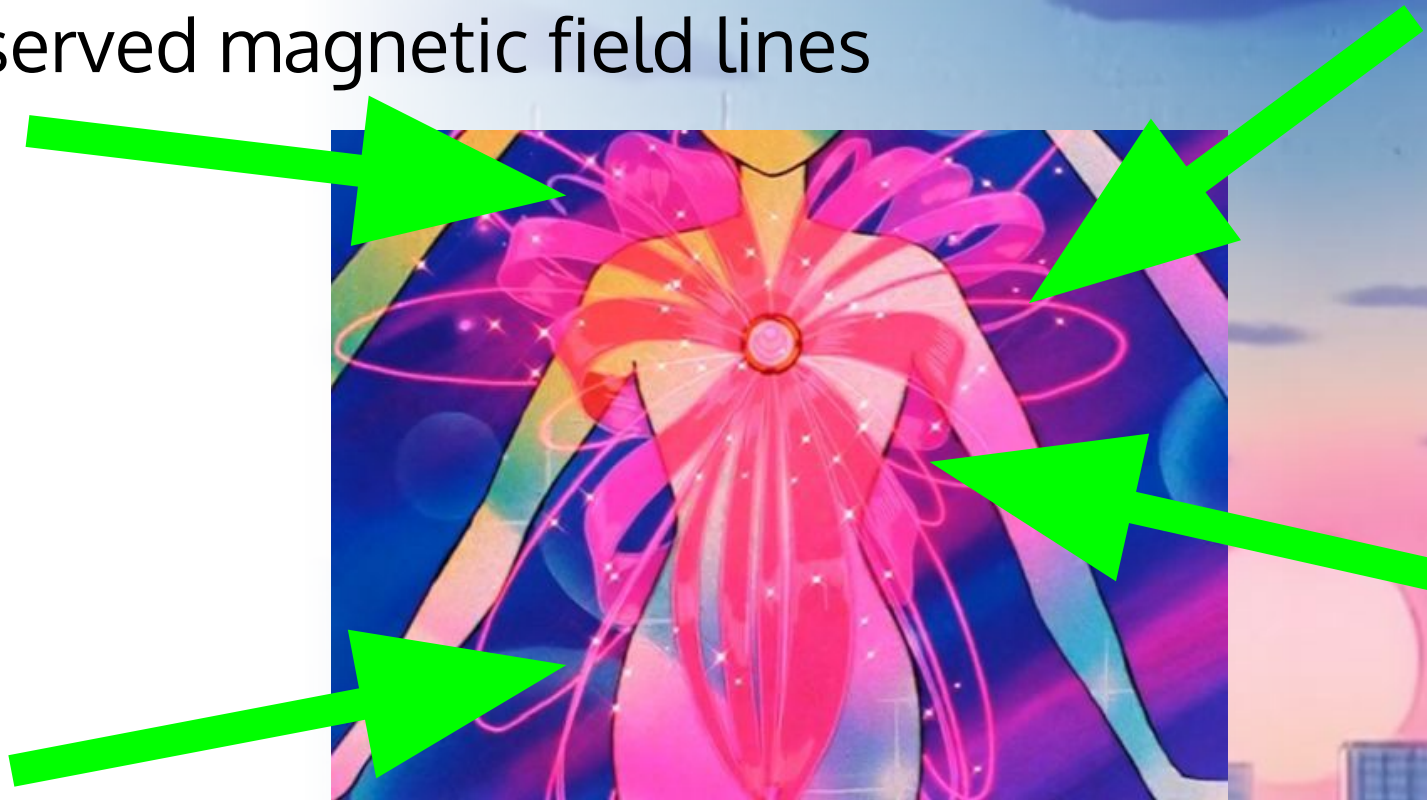


Could exosailor scouts cause fast radio bursts?

- 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
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Observed magnetic field lines

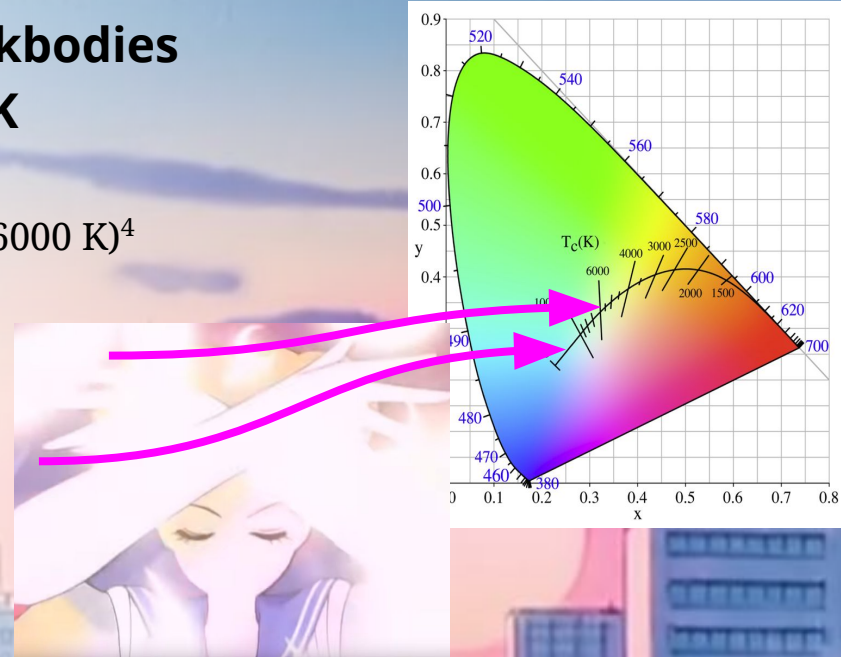


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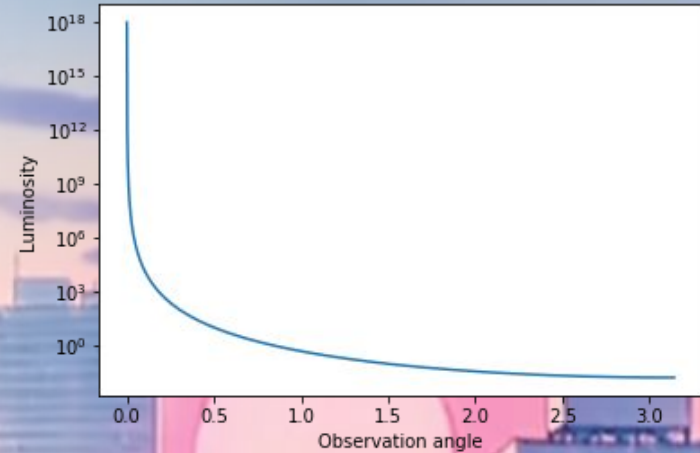
Luminosity of Sailor Scouts

- Assume Sailor Scouts are **perfect blackbodies**
- Colour temperature in excess of **6000 K**
- Stefan-Boltzmann law: $P = A\sigma T^4$
 - $L_{\text{Sailor Scout}} = 1.6 \text{ m}^2 \times 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4} \times (6000 \text{ K})^4$
 - $= 1.1758073 \times 10^8 \text{ W}$
- 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
 - $\delta = (\gamma - \cos \theta (\gamma^2 - 1)^{1/2})^{-1}$
 - $L_{\text{Sailor Scout, observed}} = \delta^{3+\alpha} L_{\text{Sailor Scout}}$



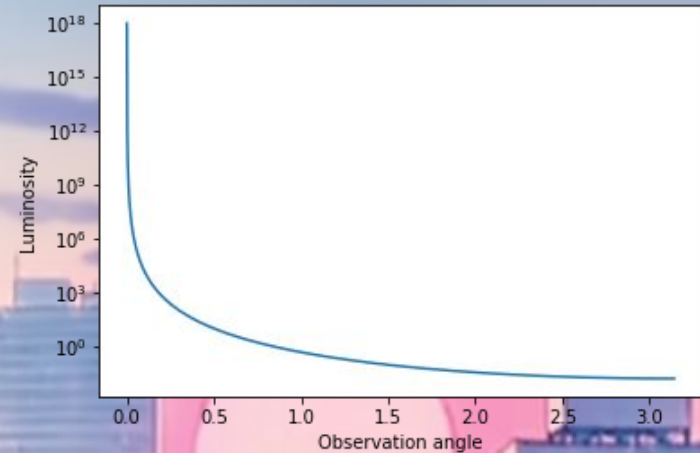
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 - Luminosities up to 10^{18} W!



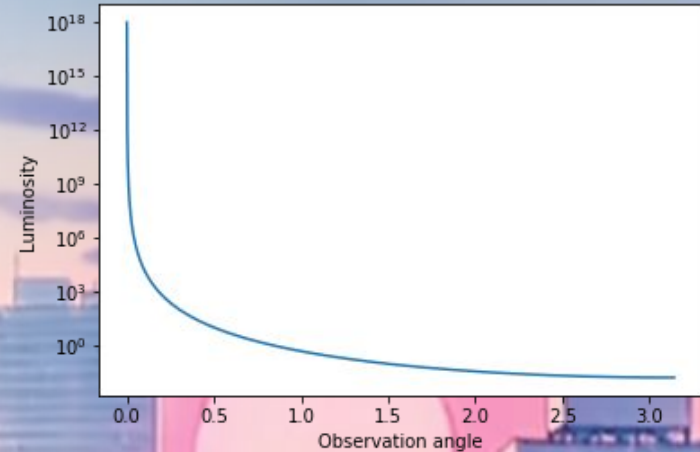
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- Brightness falls off with inverse-square law
 - $B_{\text{Sailor Scout, observed}} = \delta^{3+\alpha} L_{\text{Sailor Scout}} / 4\pi D^2$
 - Assume **non-cosmological distances**
 - Alpha Centauri $D = 4.132 \times 10^{16}$ m
 - Too faint!



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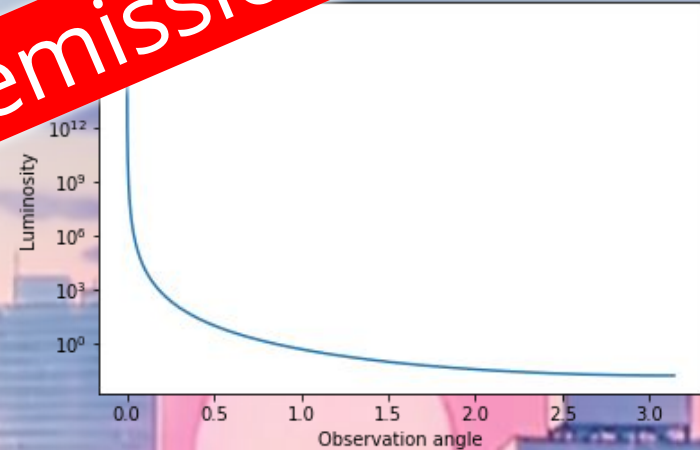
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- $B_{\text{Sailor Scout, observed}} = \delta^3 B_{\text{Sailor Scout}}$
- Assume **non-relativistic** distances
- Alpha Centauri 4.2×10^{16} m
- Too faint!

- Only one possible theory

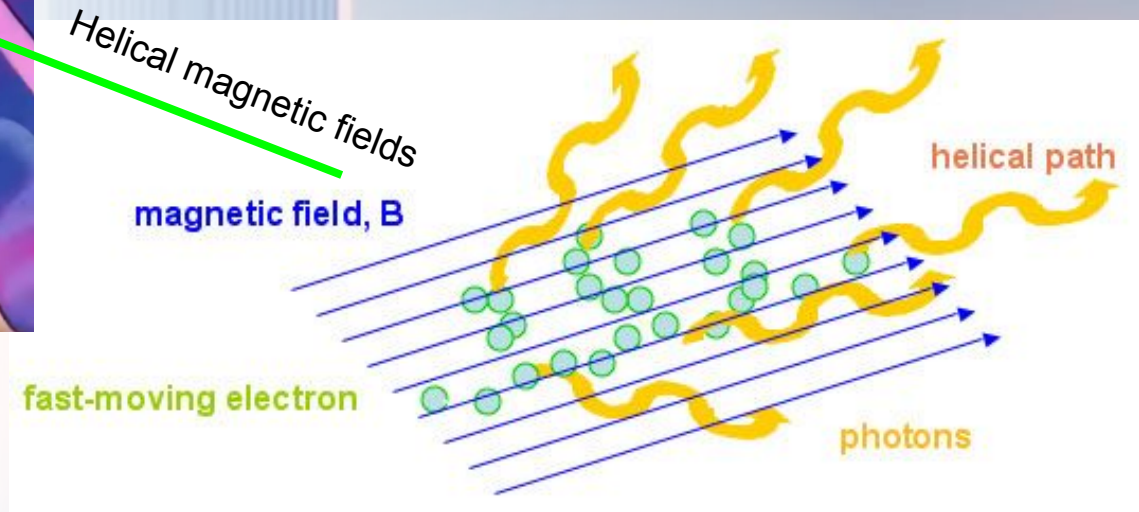
Non-blackbody emission!



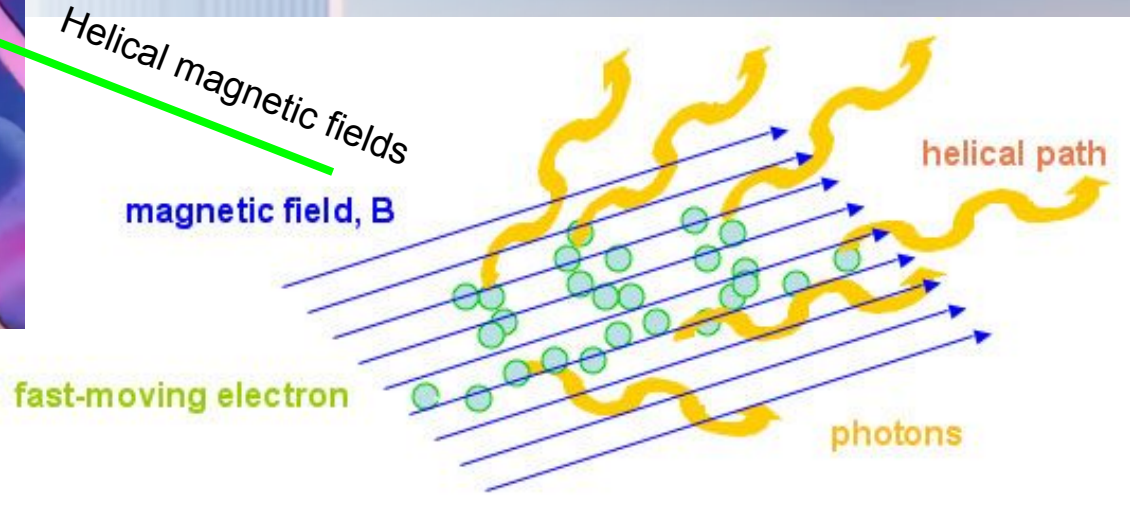
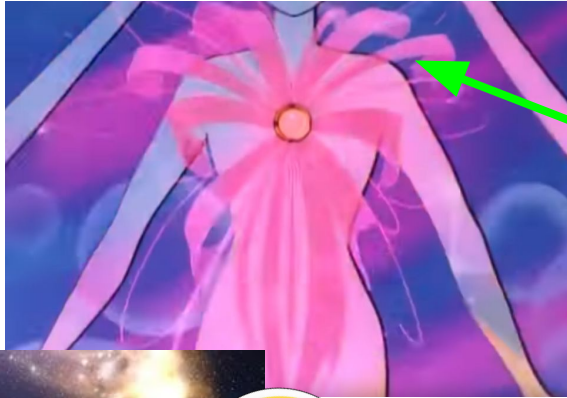
? emission from exosailor scouts



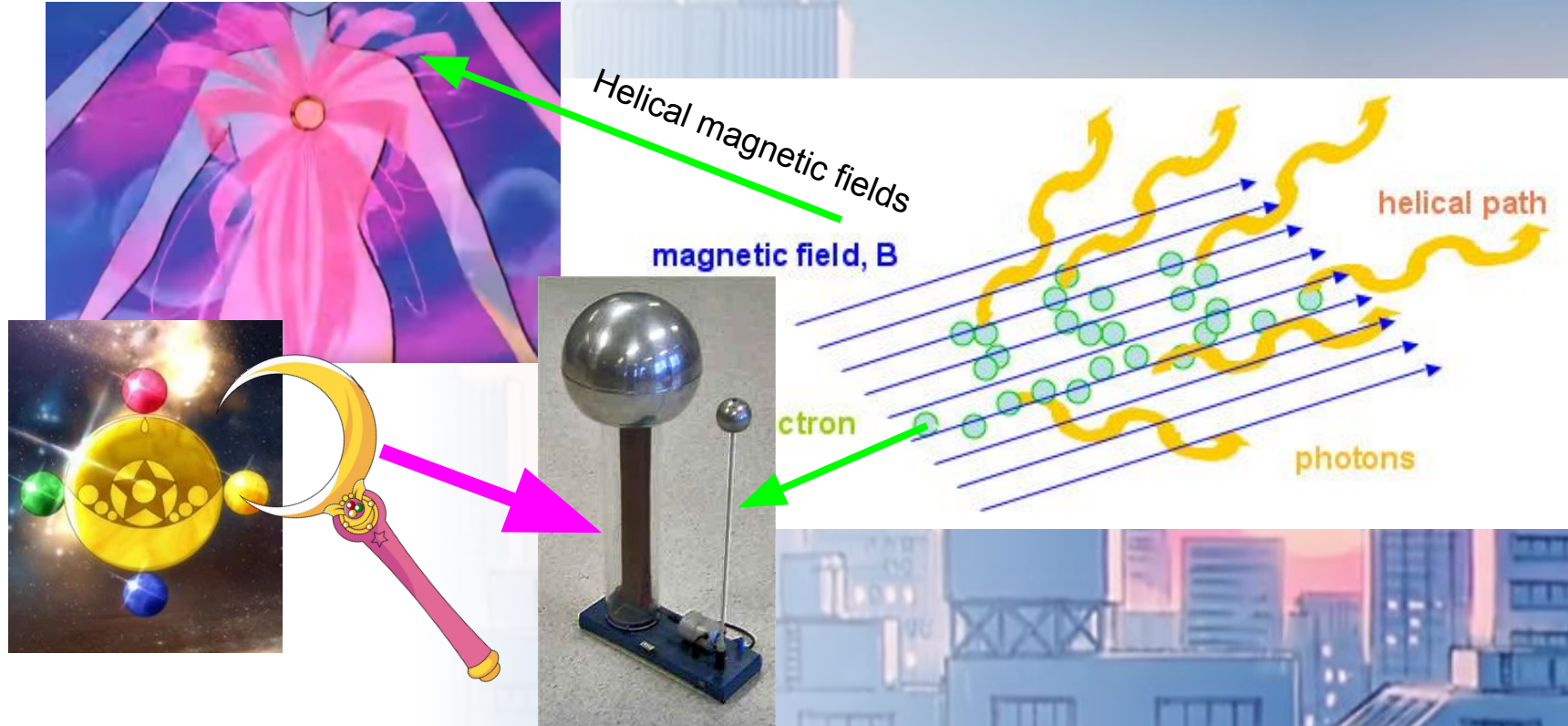
Synchrotron emission from exosailor scouts



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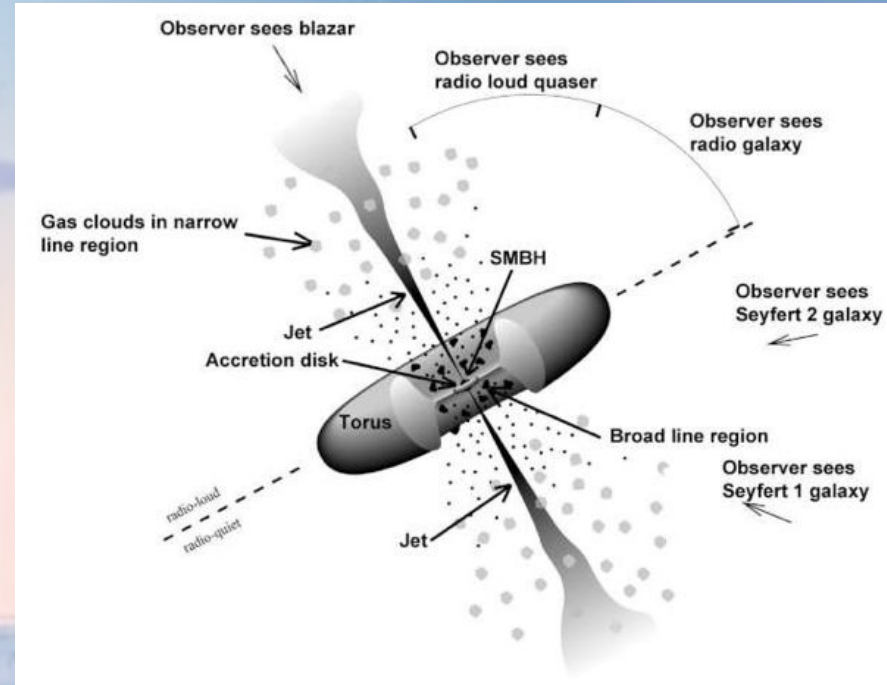
Future work

- **Next-generation** radio telescopes



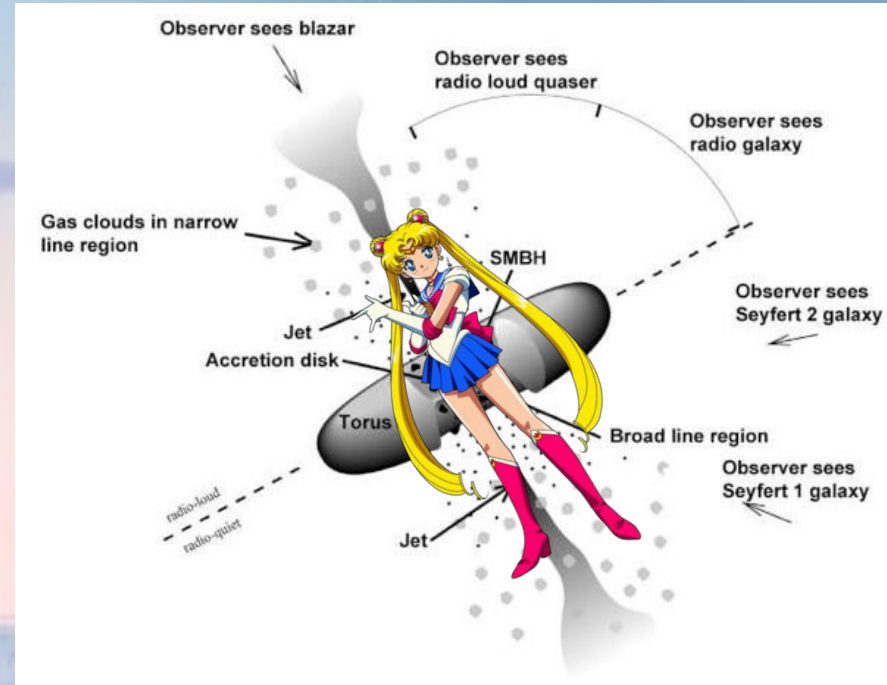
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- **Unified model** of magical girls?



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- **Unified model** of magical girls?
- Direct, **multi-messenger** detection

