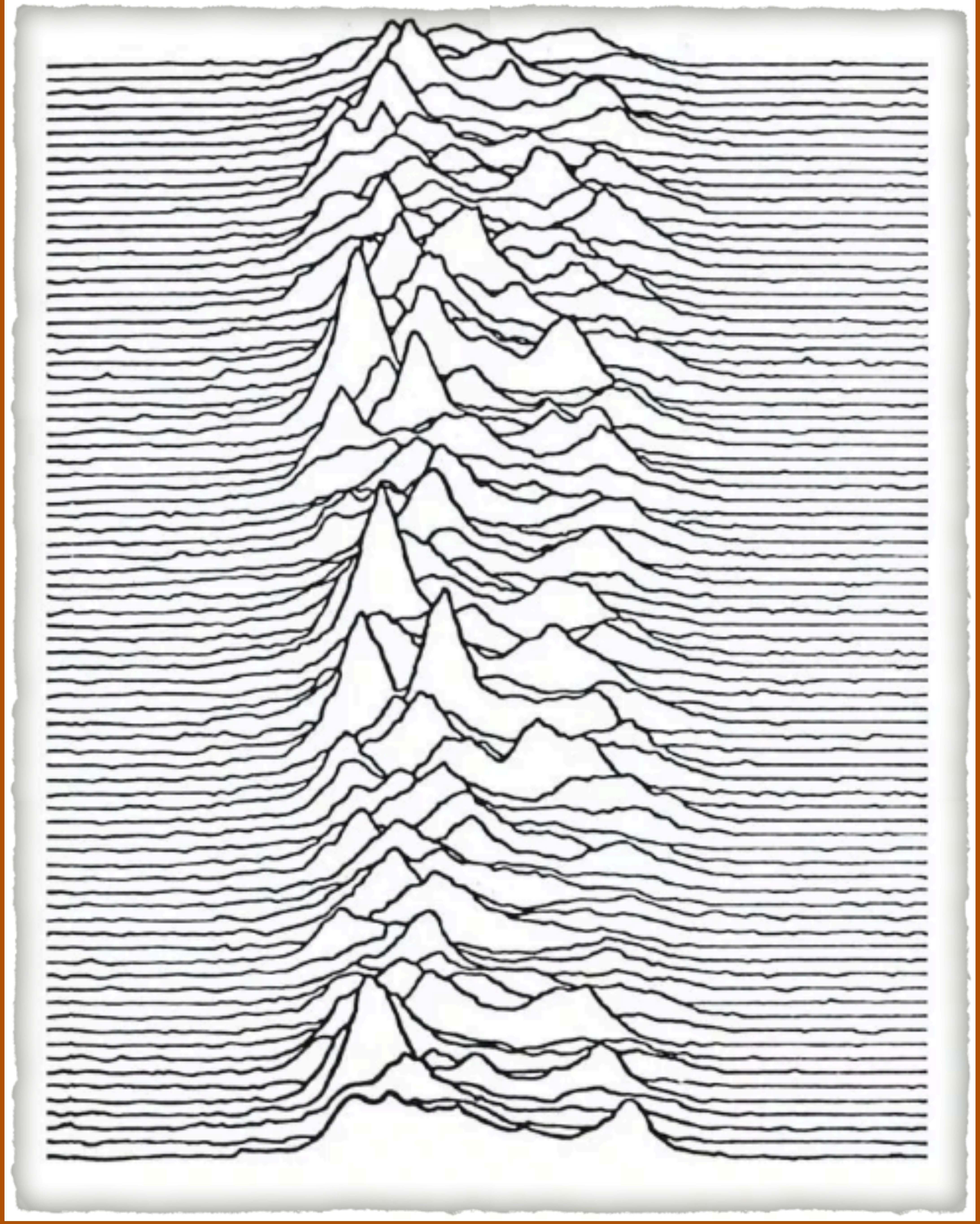
NASSP Pulsar lectures



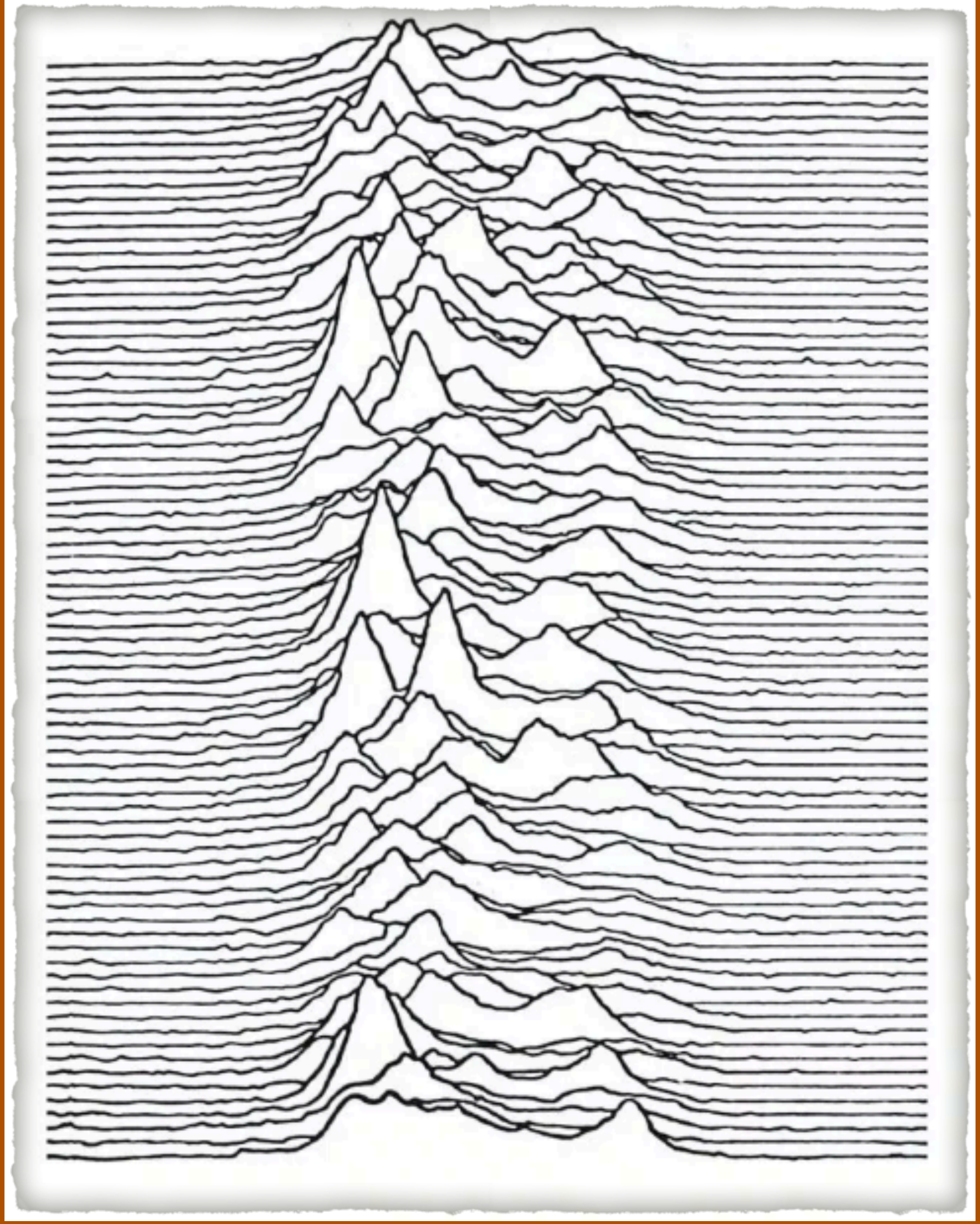
Course layout:

Lecture 1: Radio pulsar observations

Lecture 2: Pulsar properties

Marisa Geyer, SARAO

NASSP Pulsar lectures



Course material

Much of what is discussed in these lectures come from

1) NRAO `Essential Radio Astronomy' course found online at:
https://science.nrao.edu/opportunities/courses/era

2) Handbook of Pulsar Astronomy by Lorimer and Kramer

Marisa Geyer, SARAO

Pulsar lectures: learning objectives

Lecture 1: radio pulsar observations

- Discuss basic pulsar data characteristics: how average pulse profile shapes are formed, the frequencies they emit over, their frequency spectra.
- Understand the effect of the interstellar medium (ISM) on a broadband pulsar signal:
    - Given the expression for the refractive index, show how the group velocity of the pulsar emission is effected.

$$\mathrm{v_g} = \mathrm{c}\,\mu = \mathrm{c}\sqrt{1 - \left(\frac{\nu_\mathrm{p}}{\nu}\right)^2} \approx \mathrm{c}\left(1 - \frac{\nu_\mathrm{p}^2}{2\nu^2}\right)$$

    - Given expressions for the refractive index and plasma frequency compute the associated delay due to the ISM across a observing frequency band (given the DM)

$$t = 4.149 \times 10^3 \mathrm{sec}\left(\frac{\nu}{\mathrm{MHz}}\right)^{-2}\left(\frac{\mathrm{DM}}{\mathrm{pc\ cm^{-3}}}\right)$$ and $$t_l - t_h = 4.15 \times 10^3 \times \mathrm{DM} \times \left[\frac{1}{\nu_\mathrm{l}^2} - \frac{1}{\nu_\mathrm{h}^2}\right]$$

    - Explain using a diagram how to correct for the delay using incoherent dedispersion, and understand the advantage of coherent dedispersion
    - Calculate the dispersion measure (DM) given pulsar profiles at different frequencies
    - Be able to describe pulsar scattering and its effect
- Be able to use the pulsar sensitivity equation (modified radiometer equation) in calculations

Pulsar lectures: learning objectives

Lecture 2: pulsar properties

- Be able to derive and discuss the minimum density for a star spinning with period P, and compute minimum densities for a given pulsar:

$$\rho > \frac{3\pi}{P^2 G}$$

- Compute the radius of NS based on its density and mass.
- Briefly discuss the observed mass measurement distributions and its connection to the NS equation of state research
- Be able to derive the expression for the loss of rotational energy: $\dot{E} = -\frac{4\pi^2 I\dot{P}}{P^3}$
- Compute derived quantities such as the magnetic field size or characteristic age if an expression for the magnetic dipole radiation (P_{rad}) and E-dot is given. (Note you do not have to derive P_{rad}).
- Discuss the pulsar population using a P-pdot diagram

A copy of the class lecture notes can be found here:

https://github.com/marisageyer/NASSP_pulsar_lectures

To make a copy in a local directory do:

```
git clone https://github.com/marisageyer/NASSP_pulsar_lectures
```

To update a copy of the directory you already have, go to the directory (cd NASSP_pulsar_lectures) and do:

```
git pull
```

Email me with any questions: mgeyer@ska.ac.za

A copy will also be available on Vula.

Pulsar tutorial and practicals

- Go through the examples in both the tutorials we did in class for exam preparation:
- Tutorial 1: The Effect of the ISM on pulsar signals: Computing and correcting dispersion measure
- Tutorial 2: Pulsar visibility - using the radiometer equation test which pulsars MeerKAT can observe (as a function of the radiometer equation parameters)

All tutorials can be found here:

https://github.com/sbuchner/nassp_tutorial.git

To make a copy in a local directory do:

```
git clone https://github.com/sbuchner/nassp_tutorial
```

To update a copy of the directory you already have, go to the directory (cd nassp_tutorial) and do:

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git pull
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