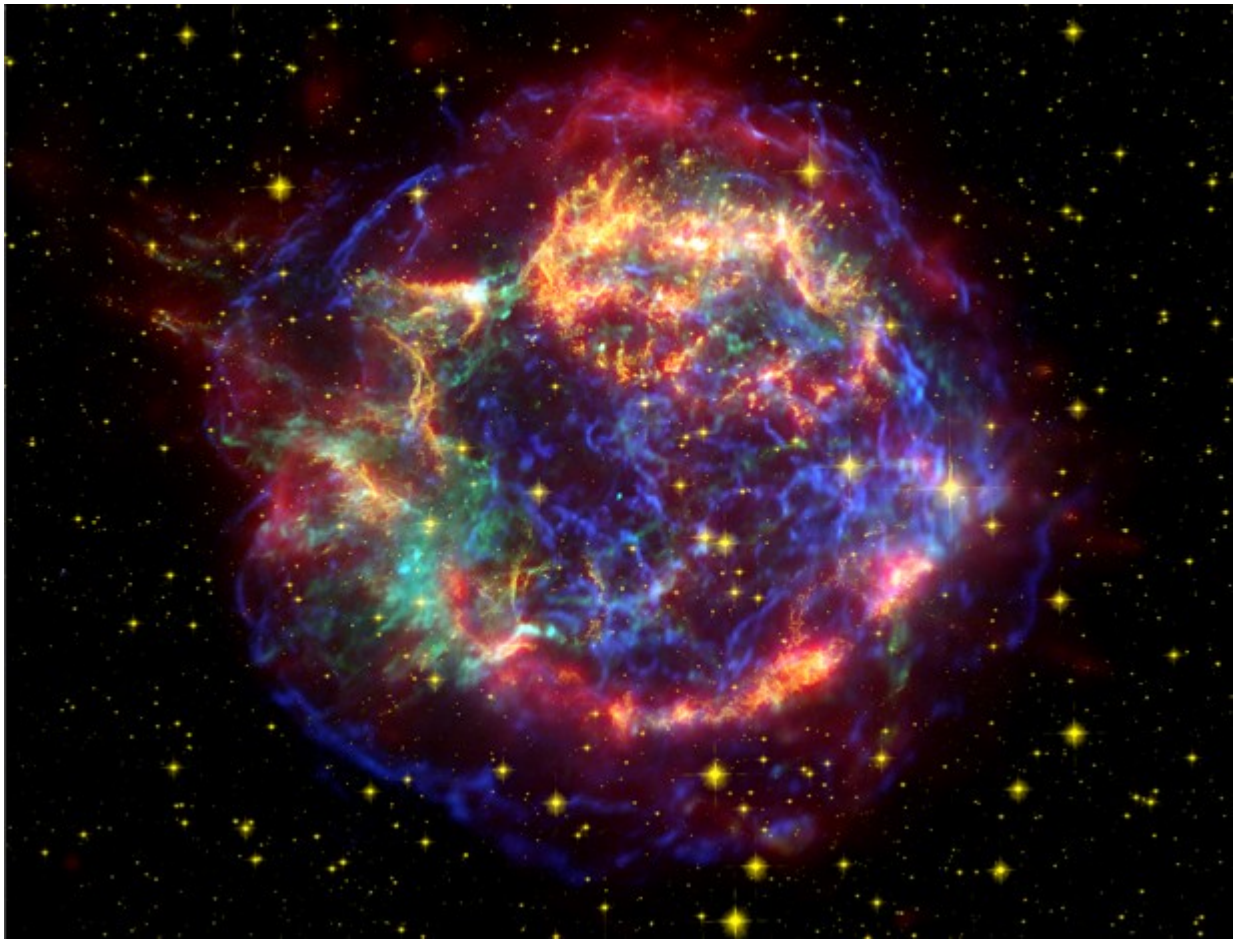
A directed search for gravitational waves from Cassiopeia A



Credit: X-ray: NASA/CXC/SAO; Optical: NASA/STScI; Infrared: NASA/JPL-Caltech

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Directed searches

- Looking for continuous gravitational waves
- Sky position known from photon astronomy
- Frequency and spindown derivatives not known
- Can set indirect upper limit on gravitational waves using distance and age, also known from photon astronomy

Indirect upper limit

- Assume all spindown in gravitational waves
- Age determines frequency to spindown ratio

$$h = \frac{1}{d}\sqrt{\frac{5GI}{2c^3}\frac{-\dot{f}}{f}} \quad \rightarrow \quad a = \frac{f}{-4\dot{f}}$$

$$\downarrow$$

$$h = \frac{1}{d}\sqrt{\frac{5GI}{8c^3 a}}$$

$$\leftarrow \quad d \rightarrow 3.4\,\mathrm{kpc},\ I \rightarrow 10^{38}\,\mathrm{kg\,m^2},\ a \rightarrow 340\ \mathrm{years}$$

$$h \approx 1.2 \times 10^{-24}$$

Cas A is interesting because...

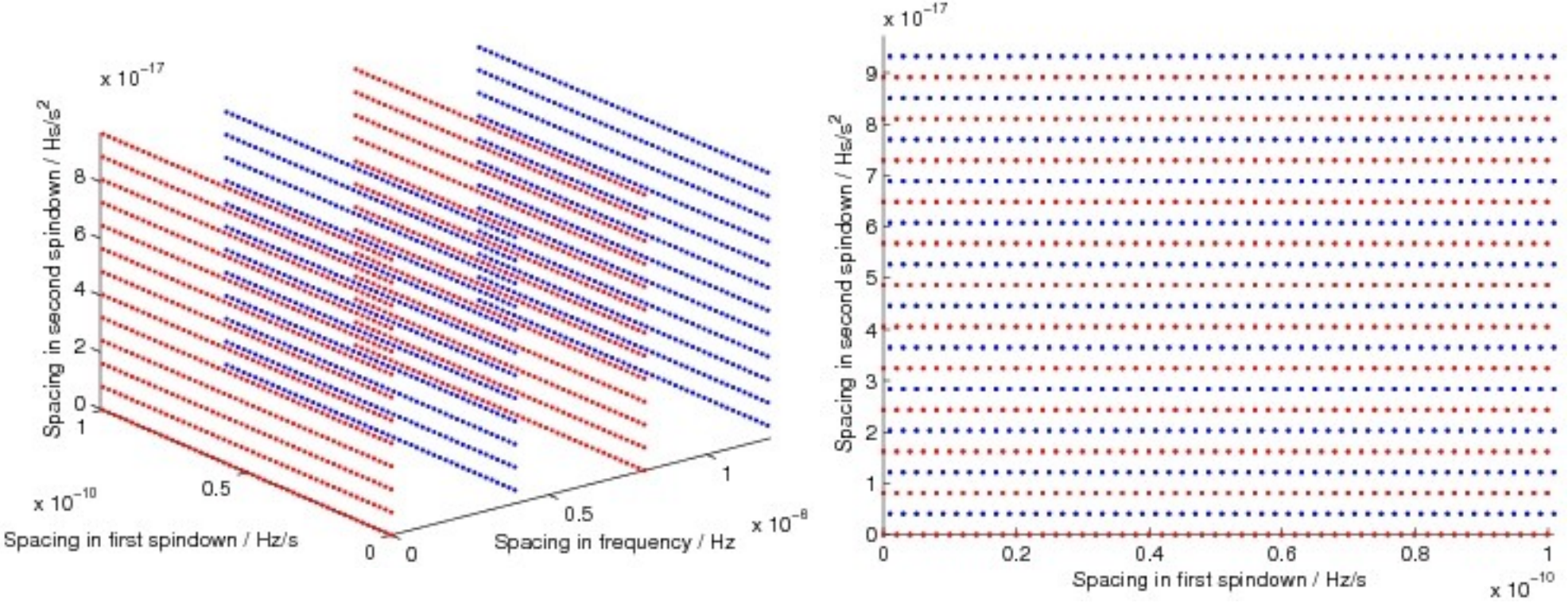
- Is the youngest such object in our Galaxy
- Has one of highest upper limits for a known isolated compact object: ~1.2 x 10^{-24} ± 10%
- We will beat indirect limit with initial LIGO over some frequency band
- More info: Ben Owen's poster

Search algorithms

- Search 3-dimensional parameter space: frequency, first and second spindown
- Limits on parameter space:
  - Frequency: computational cost
  - Spindowns: age, ...
- Optimal filtering algorithm (F statistic)
  - Coherently combines H1 and L1 data
  - Computational cost scales as (integration time)^7
  - Example: ~9 days of H1, L1 data sufficient to beat indirect limit above ~110 Hz

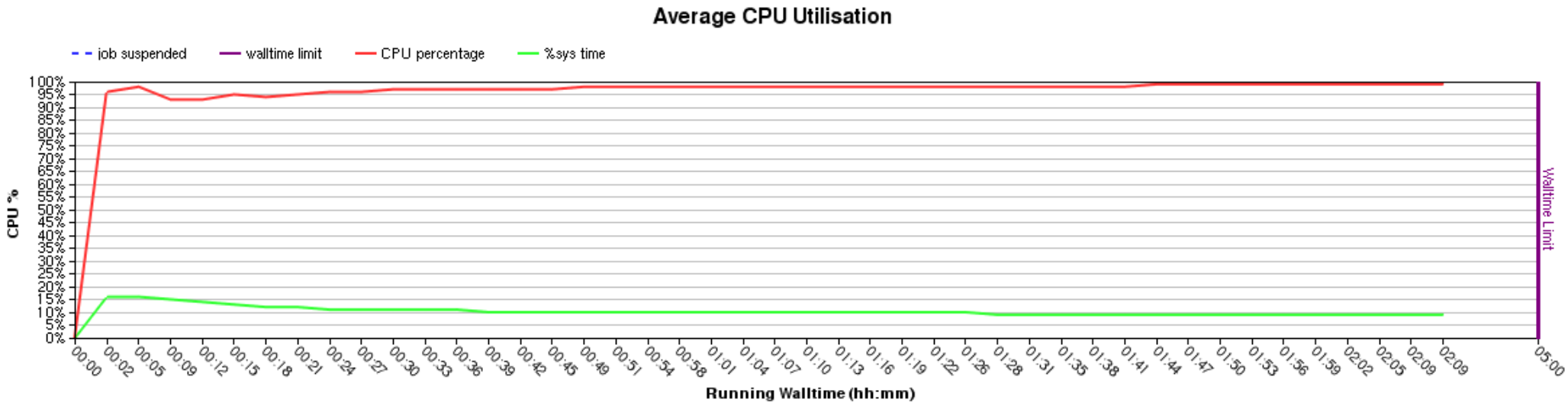
Optimal parameter space tiling

- Uses parameter space metric
  - Improvement: use off-diagonal components
- Body-centered cubic lattice



In progress

- Search running on APAC* cluster
- Parameter space divided into frequency bands
- Each jobs computes fixed number of templates
- Clocking up 1000s of CPU hours



* Australian Partnership for Advanced Computing, http://nf.apac.edu.au

How sensitive?

- Rough estimate based on H1,L1 noise curves