Template placement for the all-sky pulsar search

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Statement of the problem

- Matched filtering for continuous sources takes place in a multidimensional parameter space

$$\theta^{\mu} = (\mathrm{RA},\, \mathrm{dec},\, f,\, f_{\mathrm{spindown1}},\, f_{\mathrm{spindown2}},\, \ldots).$$

- The overlap between two templates can be characterized by

$$< u(\theta) | u(\theta + \Delta\theta) > = \int_0^T u(\theta, t)^* u(\theta + \Delta\theta, t)\, dt.$$

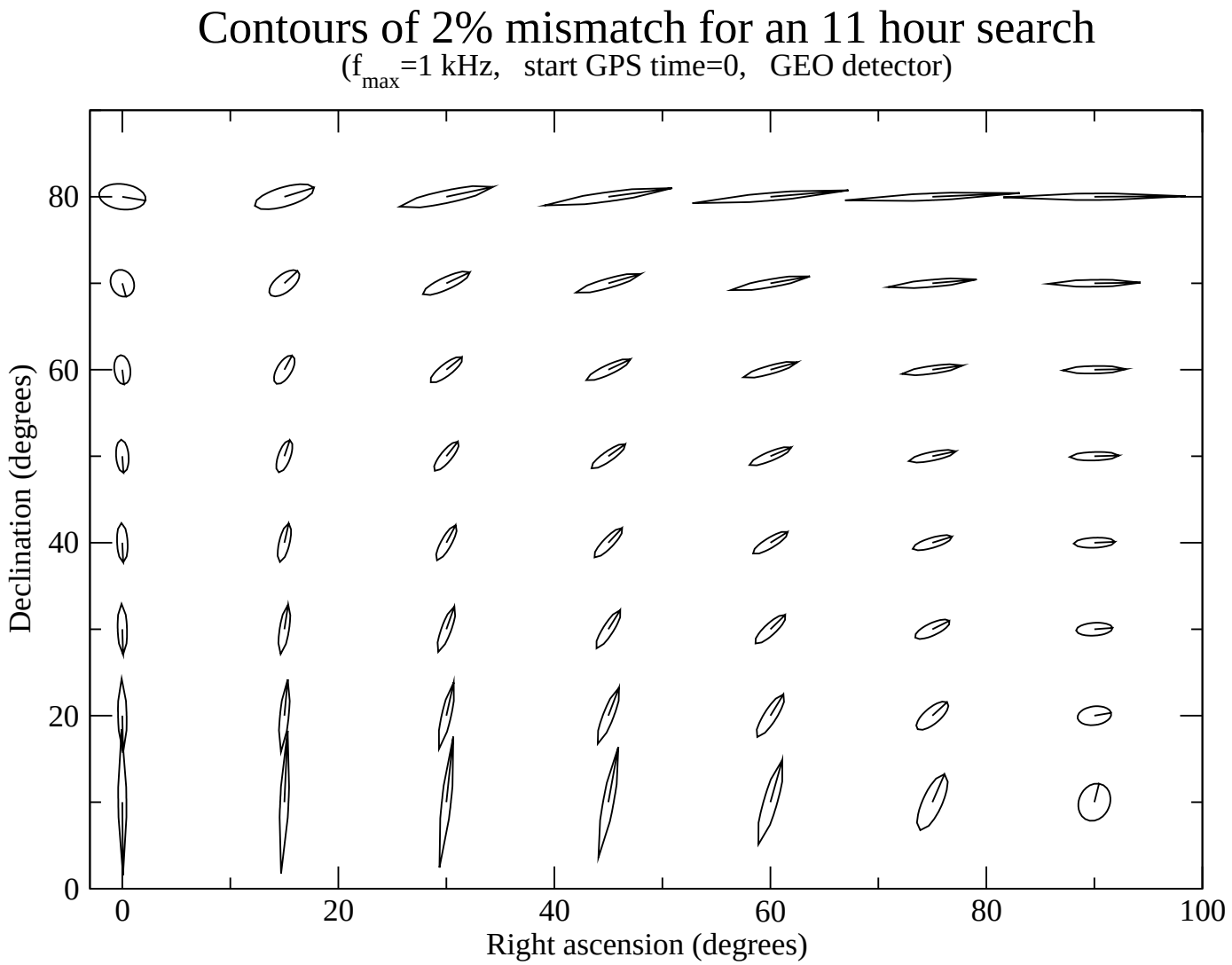
- Use a metric formalism to efficiently place the templates, with distances defined by the *mismatch*:

$$1 - m = | < u(\theta) | u(\theta + \Delta\theta) > |^2.$$

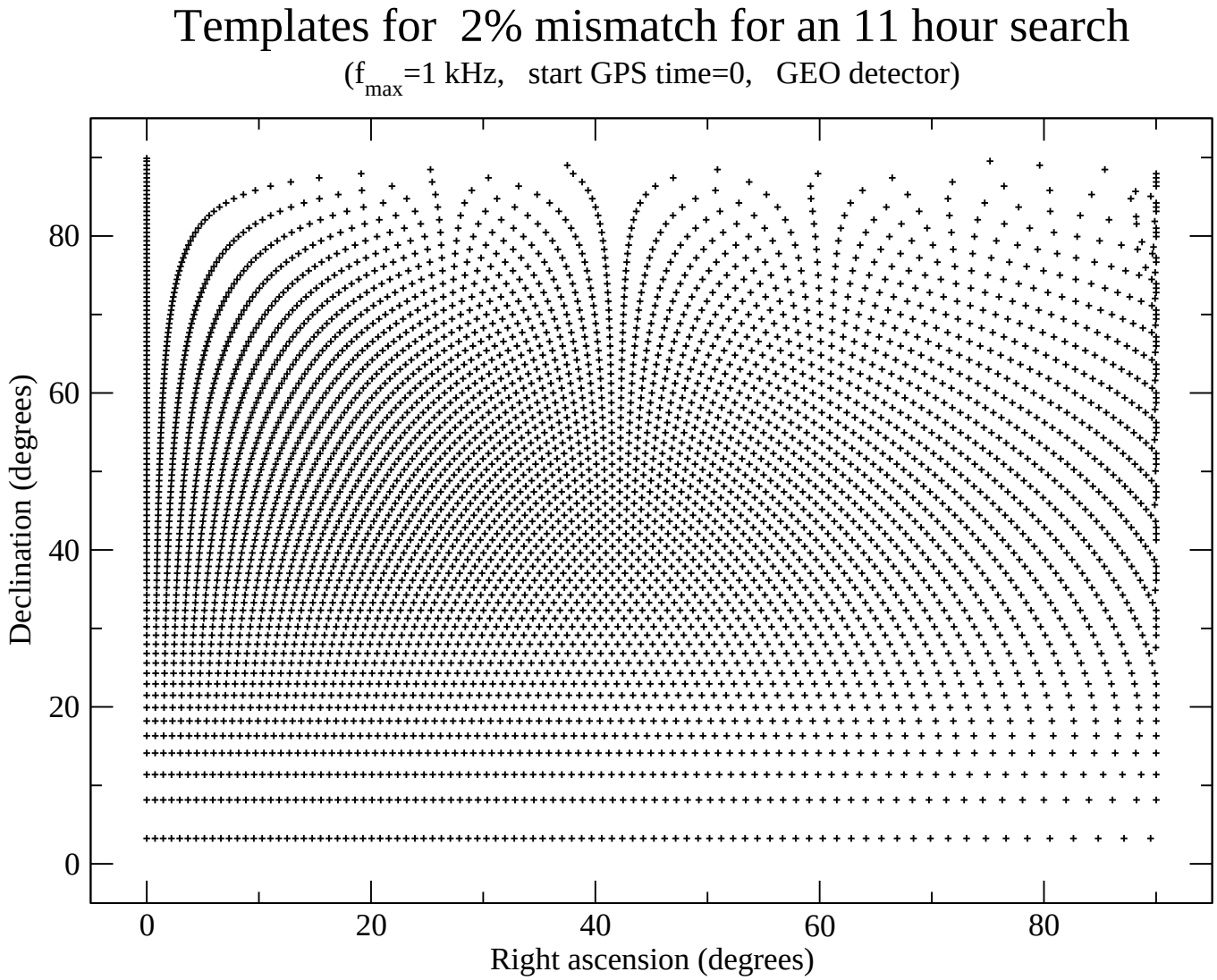
The Ptolemaic approximation

- Calculation of the metric is computationally expensive.
- Can greatly reduce this expense by using the *Ptolemaic approximation*, where the detector motion is the superposition of two perfectly regular circular motions.
- Within this approximation, the metric components can be generated analytically, affording us a **quick look** at the structure of the parameter space.
- Small errors don't kill us, as we're using this to *place* the templates, not to *generate* them.

Ellipses of constant mismatch for an octant



Template placement for an octant



Savings

- Find that parameter space would be over-covered by a factor of about 2 if smallest template spacing was used everywhere.
- Find that by splitting up the search into sub-domains, number of templates can be reduced, e.g. for 4 square sub-regions, number of templates reduced by 34%.
- These reductions can be understood by staring at the mismatch ellipses.

Up-shot

- Using fast metric-generating code we can gain insight into how best to tile parameter space.
- Will be invaluable when things become more complicated when we start adding spindown parameters.
- Writing a slow accurate code with ephemeris barycentering to validate “quick-look” code.