Detecting poorly understood sources with LIGO

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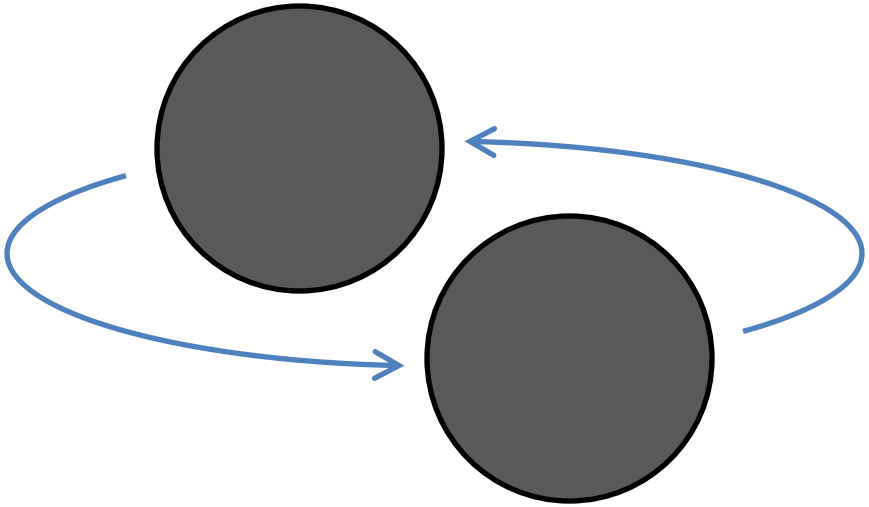
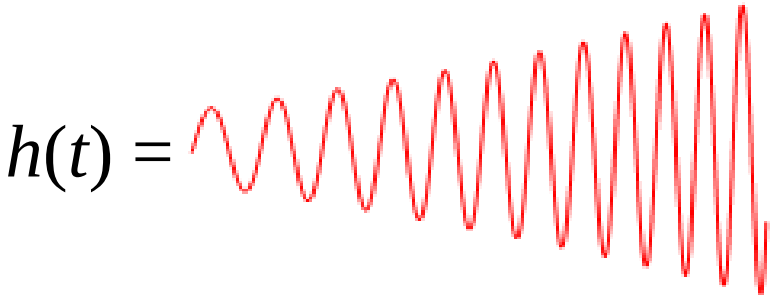
Detecting

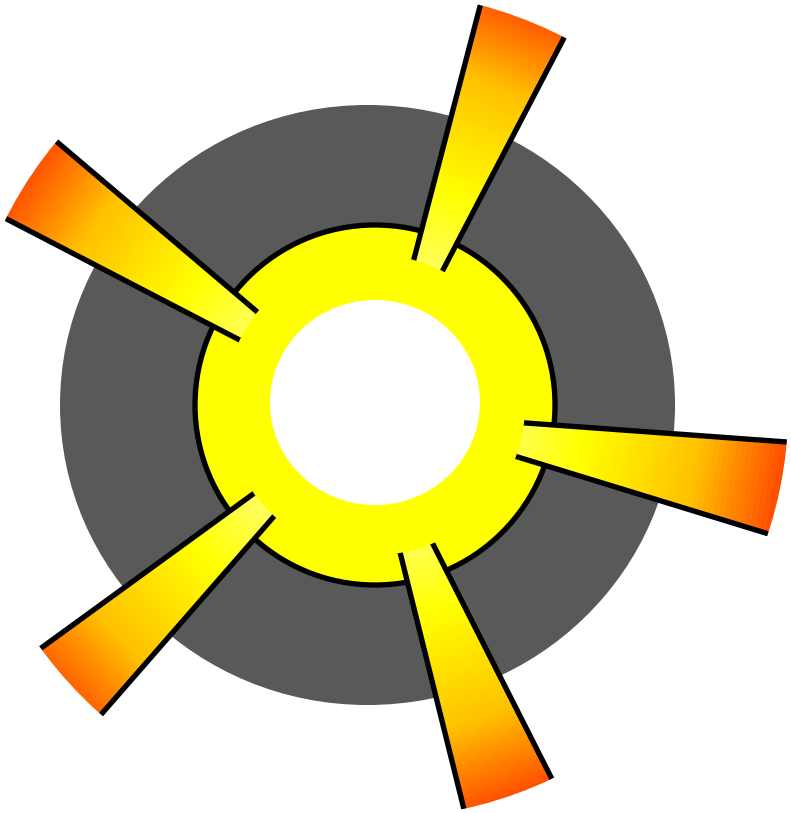
- Inspiralling compact bodies are LIGO's most plausible burst source
- The search for them is highly optimised and looks only for those known waveforms
  - Known through computer simulation and analytic approximation
- It won't find the unexpected





Poorly understood sources

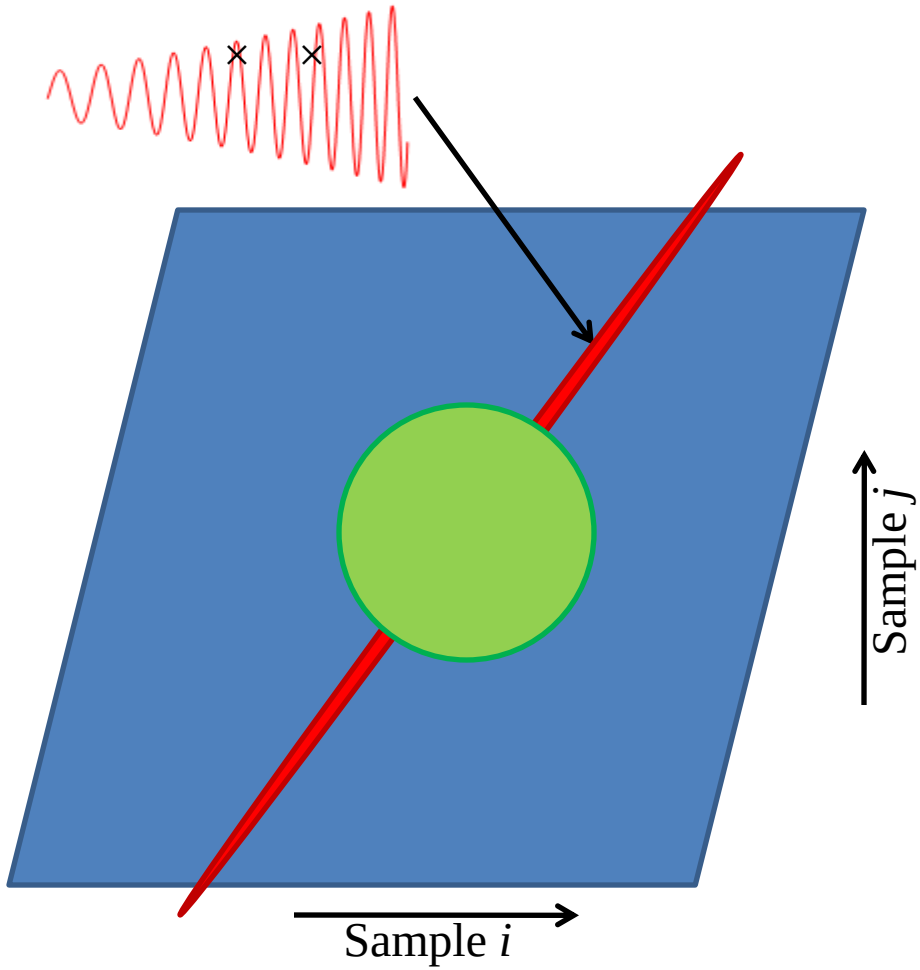
- Physical problems
  - Equation of state of very dense matter
  - Exotic sources or new physics
- Computational problems
  - Supernovae simulations
  - Inspiral simulations for some regions of parameter space
    - Enormous progress in recent years



$h(t)$ = ???

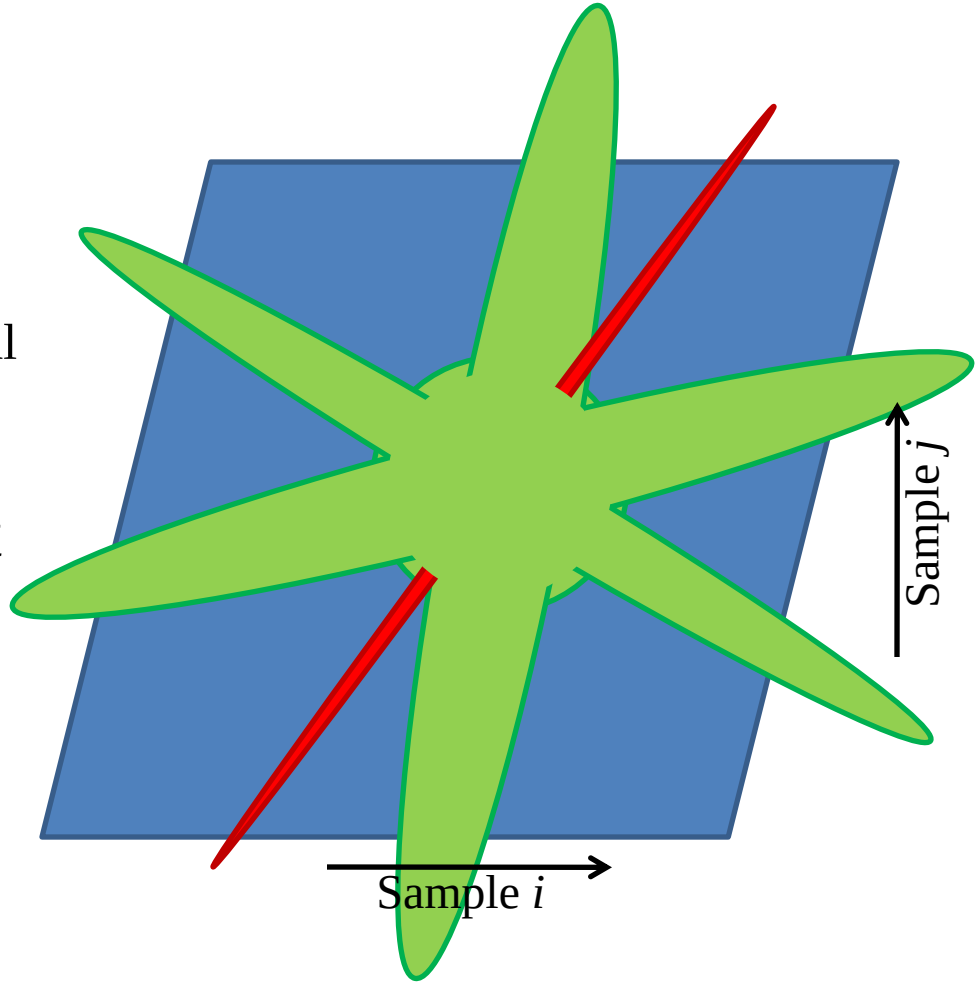
How to search for the unknown?

- Inspirals are a small fraction of all possible signals
- When we look for all possible signals, we are effectively limited to rejecting the instrumental noise hypothesis



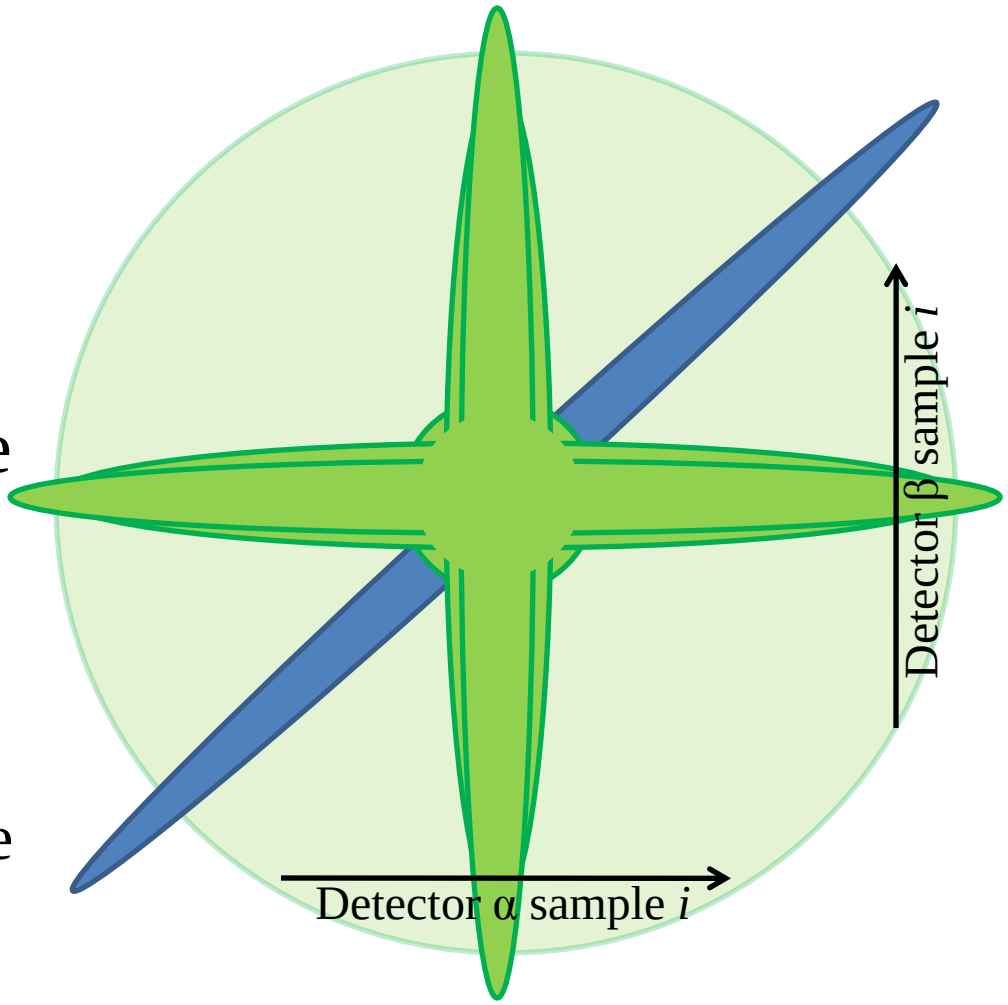
Incompletely understood detector

- LIGO experiences bursts of noise called “glitches”
  - Physical environment
    - Can veto things that occur at the same time as physical glitches
  - Unknown???
- The “glitchy” noise is not predictable enough that we can confidently pronounce something not a glitch
  - Rare for a glitch to look like an inspiral



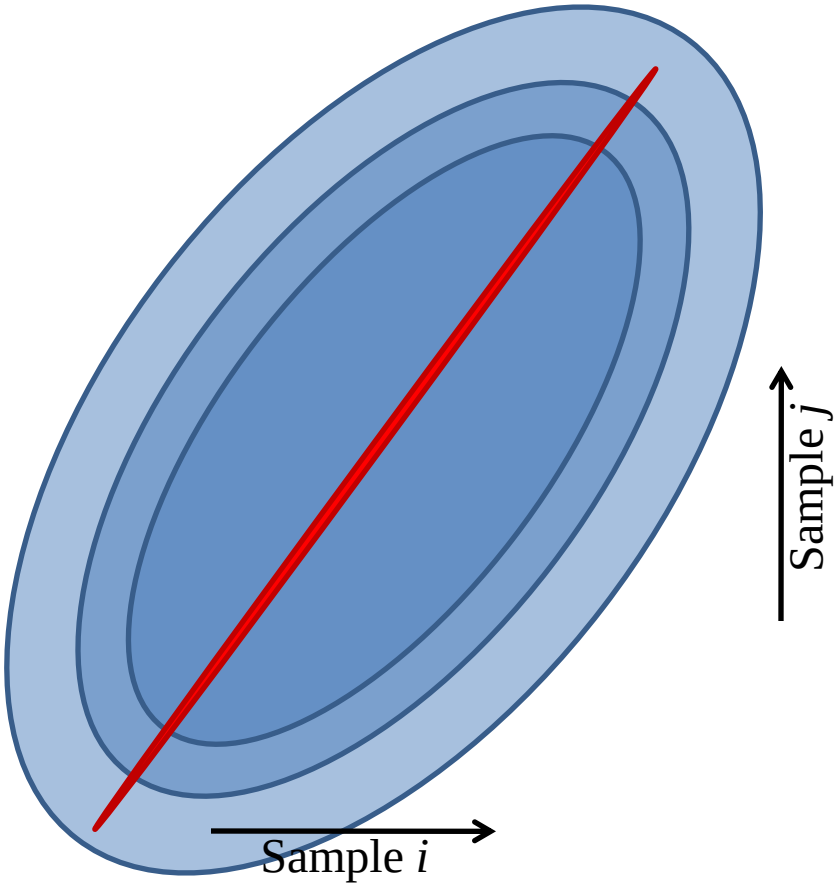
Intersite correlations

- If we consider three or more observatories, signals are constrained to lie on a subspace*
- Independent glitches are constrained to lie on other subspaces
  - Glitches in different detectors at the same time with the same shape are very, very rare



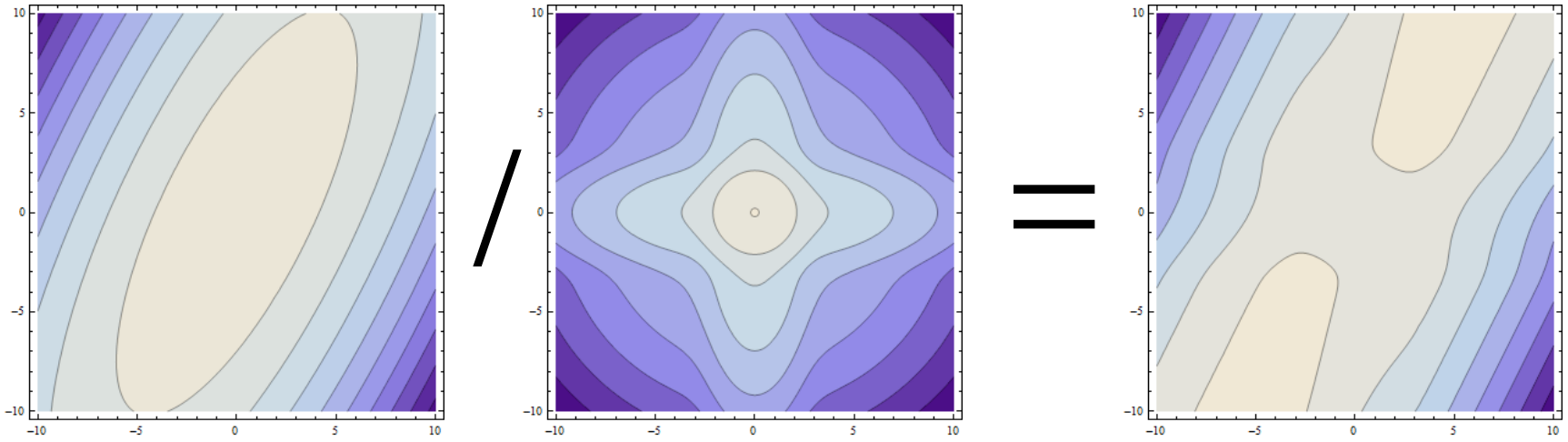
Semi-known search

- We do know something about “unknown” bursts
  - Uniform spatial distribution implies power law amplitude distribution
  - Simulations suggest morphology if not exact waveform
  - Et cetera



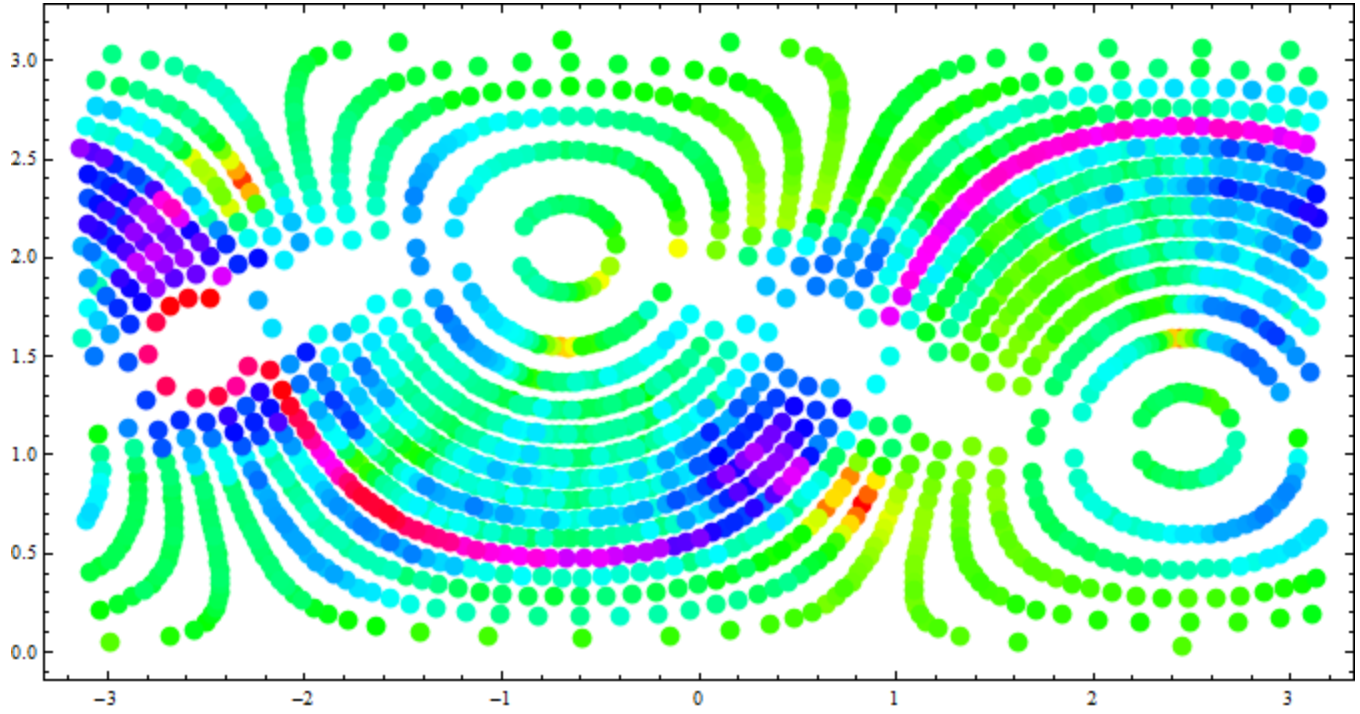
Bayesian synthesis

- Consider all data from all detectors
- Best bet signal model
  - Very general to express ignorance
- Best bet noise model
  - Long tails for glitches
- All desired features occur naturally
  - Efficient for quite flexible class of priors



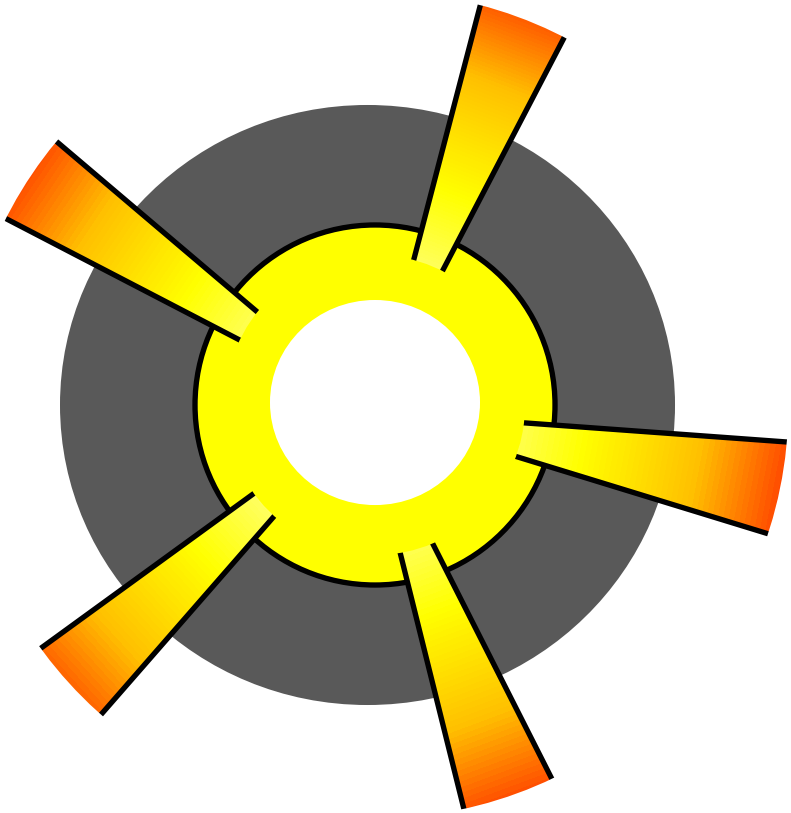
Directionality

- Have to do the search above for each direction, which brings its own fascinating problems...
  - Sky-map of the plausibility of a signal over directions



Conclusions

- Challenging!
  - Necessary if we want to be surprised by LIGO
- Information improves our sensitivity
  - Bayesian inference provides the framework to turn our knowledge into a search



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