# Observers use $h_0$!!!

- Not amplitude of $h(t)$ — which detector? sky position? etc.
- Not anything called $h_c$ — $h\sqrt{n}$ or other versions.
- $h_0$ (Jaranowski, Królak, & Schutz 1998) is amplitude of tensor

- $h(t) = F_+ h_+(t) + F_\times h_\times(t)$ = (GW tensor) contract (detector tensor)

  $h(t)$: detector response; $F_+, F_\times$: det. beam patterns; $h_+(t), h_\times(t)$: polarizations

  $= h_0 \times$ a mess of trig at two frequencies

  split by 1/1 day — guess why?

- Puts all-sky results on equal footing
- Simple $\frac{dE}{dt} = \frac{1}{10}\omega_r^2 z^2 h_0^2$

- Detectable $h_0$?

  Think $\rho^2 = \int dt \frac{h(t)^2}{S_h} = h_0^2 \times \frac{T_{coh}}{S_h} \times$ trigness

  ($T_{coh}$: constant!)

Thus sensitivity or min. detectable $h_0$ goes as

$$h_0 > \Theta \sqrt{\frac{S_h}{T}}$$ where $\Theta \approx 11$ & up (exercise)

Lower is better!

# Matched filtering requires multiples

- JKS defined $h_0$ and $\mathcal{F}$-statistic:
  basically $2\mathcal{F} = h_0\sqrt{T/S_h}$

- Sum of 4 matched filters
- Like looking for $\cos(\omega t + \phi)$:
  - could search over $\phi$ for fixed $\omega$
  - but instead make 2 filters: $\cos\omega t$, $\sin\omega t$
  - add in quadrature → $\chi^2$ w/ 2 d.o.f. (gauss noise)
- Here 4 d.o.f. (from 2 pieces) $\chi^2$

- (Pulsar searches also use heterodyning w/ Bayesian processing of output, sensitivity is SAME.)

- This is "known pulsar search" — known sky position & Doppler, known $f$, $\dot{f}$, ... in fact full timing solution, any glitches etc.

# Semi-coherent methods rule

- Want to search years of data coherently (M.F. or equivalent)? — use every CPU on planet

- Einstein @ Home — google it! try it!
  currently running > 1600 Tflops
  has 2-3 day coherence time
- Cas A type searches have <100 days (drop rest)

- How do they do it?
  - chop into shorter pieces: ~100/yr for E@H
  - integrate each piece coherently
  - add power of each piece incoherently

- Matched filtering intuition: $h^2 = (h_1 + h_2)^2$
  incoherent loses cross terms as payment for CPU cost

$$\rho \propto \sqrt{T_{coh}} \times N_{pcs}^{1/4}$$

CPU cost can go as $T_{coh}^4$ or $T_{coh}^7$ or...

- (Also PowerFlux, StackSlide, Hough transform...)