p, **q** parameterise plane orthogonal to N (plane of the sky), and define how h_{ij} is decomposed into h_+ and $h_\times$. **p** and **q** are NOT observable.

- The line ☊ indicates semi-major axis of orbital trajectories, projected onto the sky
- The sum $\Psi+\Omega$ indicates the overall rotation of ☊ relative to the equatorial plane of the Earth. This *is* observable, even though Ψ and Ω individually are not.
- If $\Psi+\Omega=90$deg, then the semi-*major* axis of the projected orbital ellipse is parallel to the rotation axis of the Earth, i.e. points north-south

Injection Coordinates

q=Y

p=X
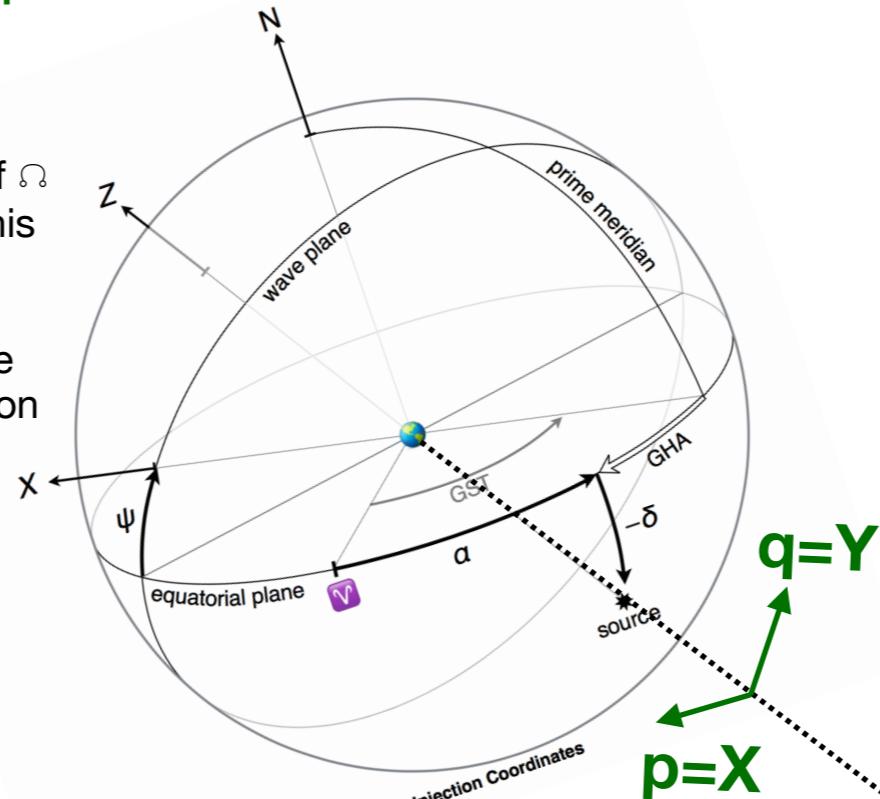
lalinference_o2
- spins defined in source frame (x',y',z')
- Sx'=**S**\cdot\hat{**x'** = **direction of periapsis**} [link]
  Sz=**S**\cdot\hat{**z'=L'**}
- Usually **X'**=**x'**=☊., i.e. $\Omega'=\omega'=0$ and **z'**\in span(**Y',Z**). *Then Sx',Sy' depend on choice of **X'**, i.e. on (some of) {α, δ, Ψ}*
- For [ChooseTD] 'phiRef = GW phase at end', i.e. Φ'=???
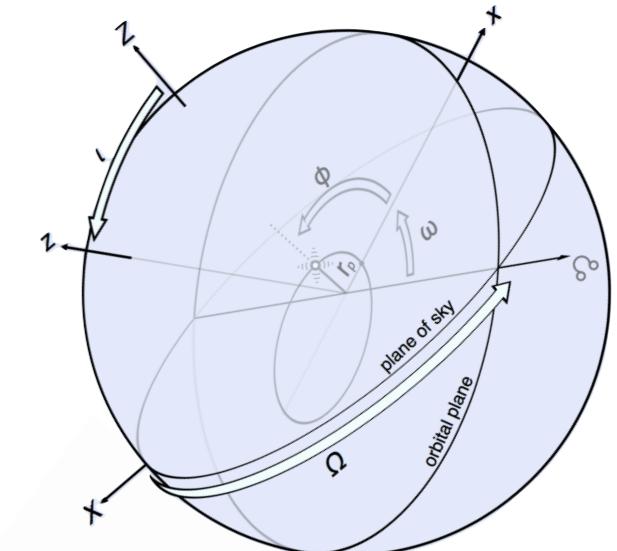
https://git.ligo.org/lscsoft/lalsuite/blob/lalinference_o2/lalsimulation/src/lalsiminspiral_orbitelements.svg
https://git.ligo.org/lscsoft/lalsuite/blob/lalinference_o2/lalsimulation/src/LALSimInspiral.h

master vs lalinference_o2
- **Z=Z'**, **L=L'**, $\Omega=\Omega'$
- X'=☊=Y, i.e. $\Omega'=0$, $\Omega=\pi/2$, i.e. different polarization basis {**p**, **q**}
- $\Psi' = \Psi+\pi/2$
  - change in **p,q** ⇒ change in polarization
  - preserves $\Psi'+\Omega'=\Psi+\Omega$
- {x,y} & {x',y'} are linear combinations of each other:
  - Expand ☊=**x'**=**Y**:
  - **x'** = cosΦ **x** - sinΦ **y**, **y'** = sinΦ **x** + cosΦ **y**
- Sx, Sy are same linear combinations
  - Sx' = cosΦ Sx - sinΦ Sy
  - Sy' = sinΦ Sx + cosΦ Sx
- Because $\omega=0$, Φ=Φ'. But Φ' inconsistently defined by lalinf_o2 waveform models, so must verify for each model whether same phiRef yields Φ=Φ'.
- **To backport code on master to lalinference_o2:**
  1. Set Sx=cosΦ Sx'+sinΦ Sy',
     Sy=-sinΦ Sx'+cosΦ Sy', and Sz=Sz'
  2. Call master's ChooseTDWaveform w/ longAscNodes=0 (i.e. $\Omega=\pi/2$)
  3. Un-rotate polarizations by $\pi/2$, $(h_+,h_\times)=-(h_+,h_\times)$

master
- spins defined in source frame (x,y,z)
  Sx=**S**\cdot\hat{**x** = **body2 ➔ body1**} [link]
  Sz=**S**\cdot\hat{**z = L**}
- Ω=longAscNode+$\pi/2$,
  i.e. for longAscNodes=0, **Y** = ☊, **z**\in span(**X,Z**) [this choice was already implemented by many approximants, despite its inconsistency with the 'old' documentation]
- **Z**=sin(i)sin(Φ) **x**+sin(i)cos(Φ) **y**+cos(i) **z**
     =\hat{**r**}(θ=i, $\varphi=\pi/2-\Phi$) [xyz-spherical coords]
- For [ChooseTD] phiRef=Φ
- ChooseTD defines location of periastron by mean-anomaly=$2\pi(t - T_{last\,peri})/(T_{next\,peri} - T_{last\,peri})$, and not by angle δ.
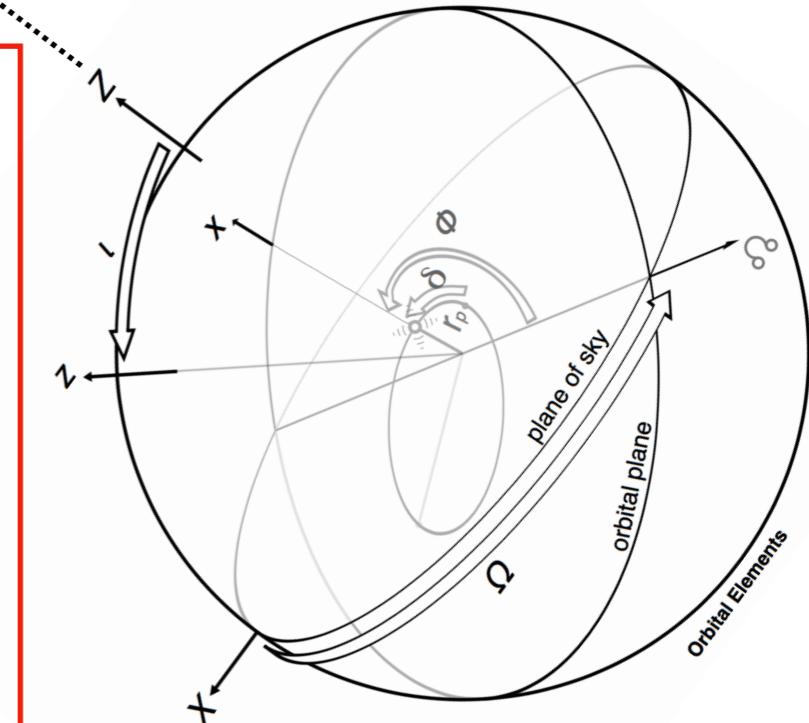
https://git.ligo.org/lscsoft/lalsuite/blob/master/lalsimulation/lib/lalsiminspiral_orbitelements.svg

Harald Pfeiffer, T1800226-v4