Relatividade Geral, Ondas Gravitacionais, Objetos compactos, Cosmologia, Teorias alternativas, etc

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Breve histórico

1990: Doutor pelo IAG/USP

2001: Livre-docência pelo IAG/USP

2002: Pesquisador Associado INPE (concurso público)*

2006: Pesquisador Titular INPE

Mais informações: CV Lattes

*1998 – 2002: Jovem Pesquisador FAPESP – INPE

Ponto de partida ….

$$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2}\, g_{\mu\nu} R = 8\pi T_{\mu\nu}$$

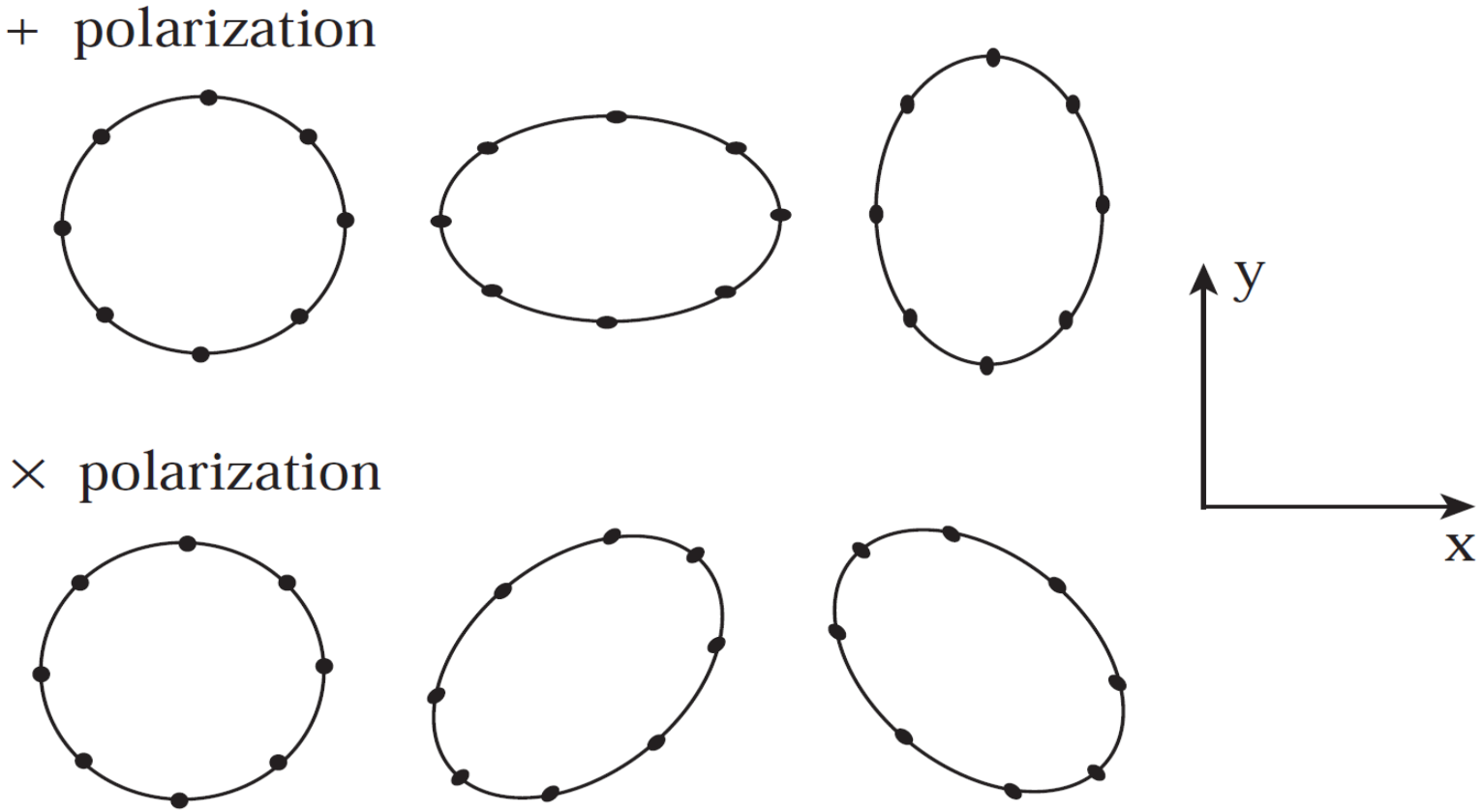
$$ds^2 = g_{\alpha\beta}\, dx^\alpha dx^\beta$$

$$T^{\alpha\beta} = (\rho + p)\, u^\alpha u^\beta + p\, g^{\alpha\beta}$$

Ondas Gravitacionais

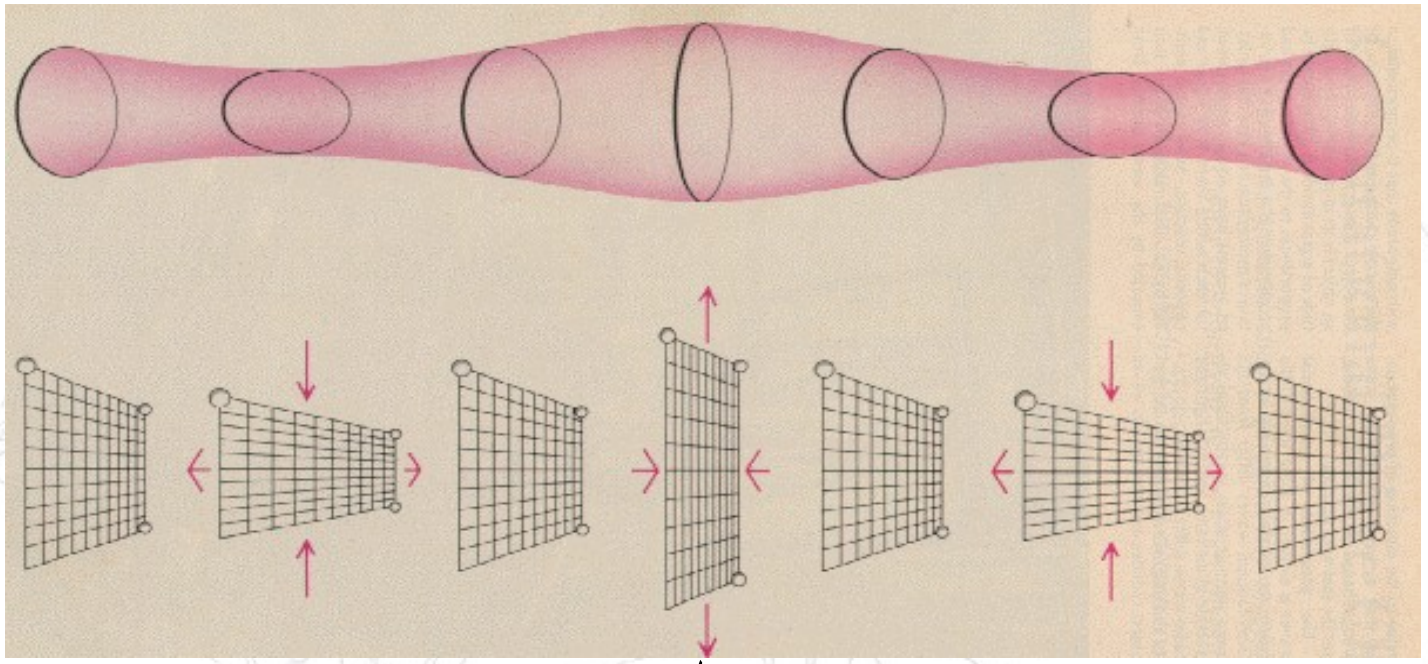
$$g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu} \ , \qquad |h_{\mu\nu}| \ll 1$$

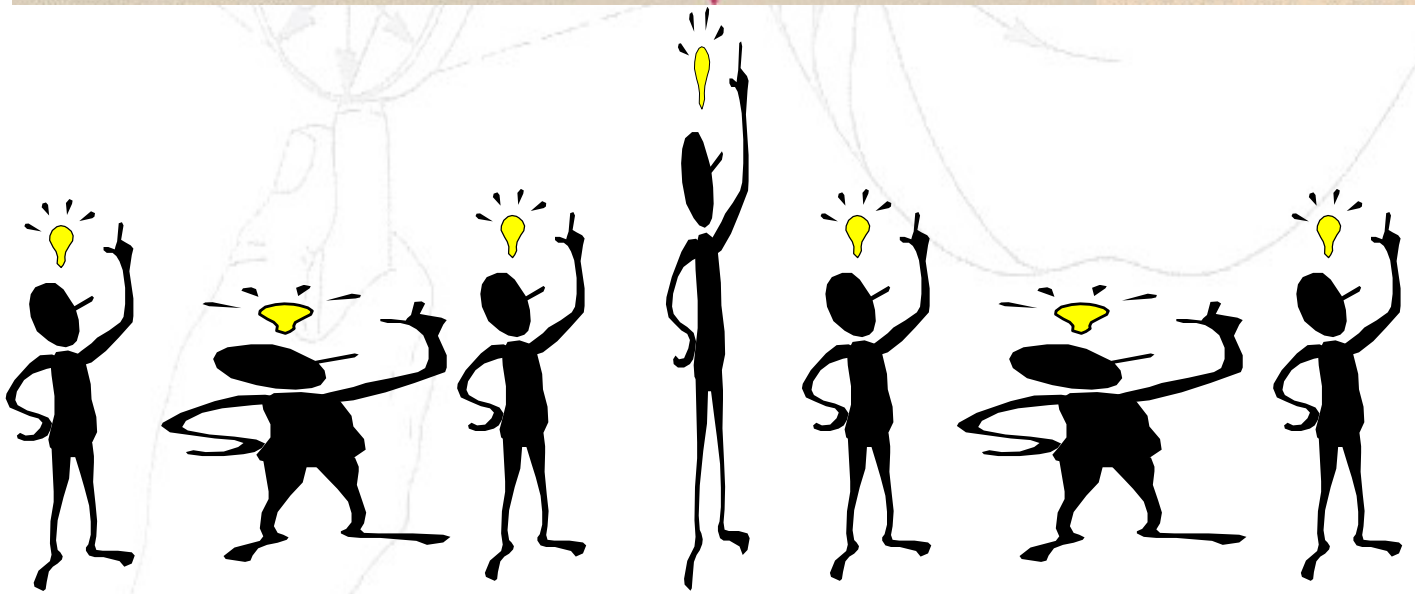
$$\Box \bar{h}_{\mu\nu} = -16\pi T_{\mu\nu}$$



Amplitude da onda: $h = \Delta L/L$

Freqüências das ondas: 10^{-18} Hz a 10^{10} Hz





Relatividade Geral

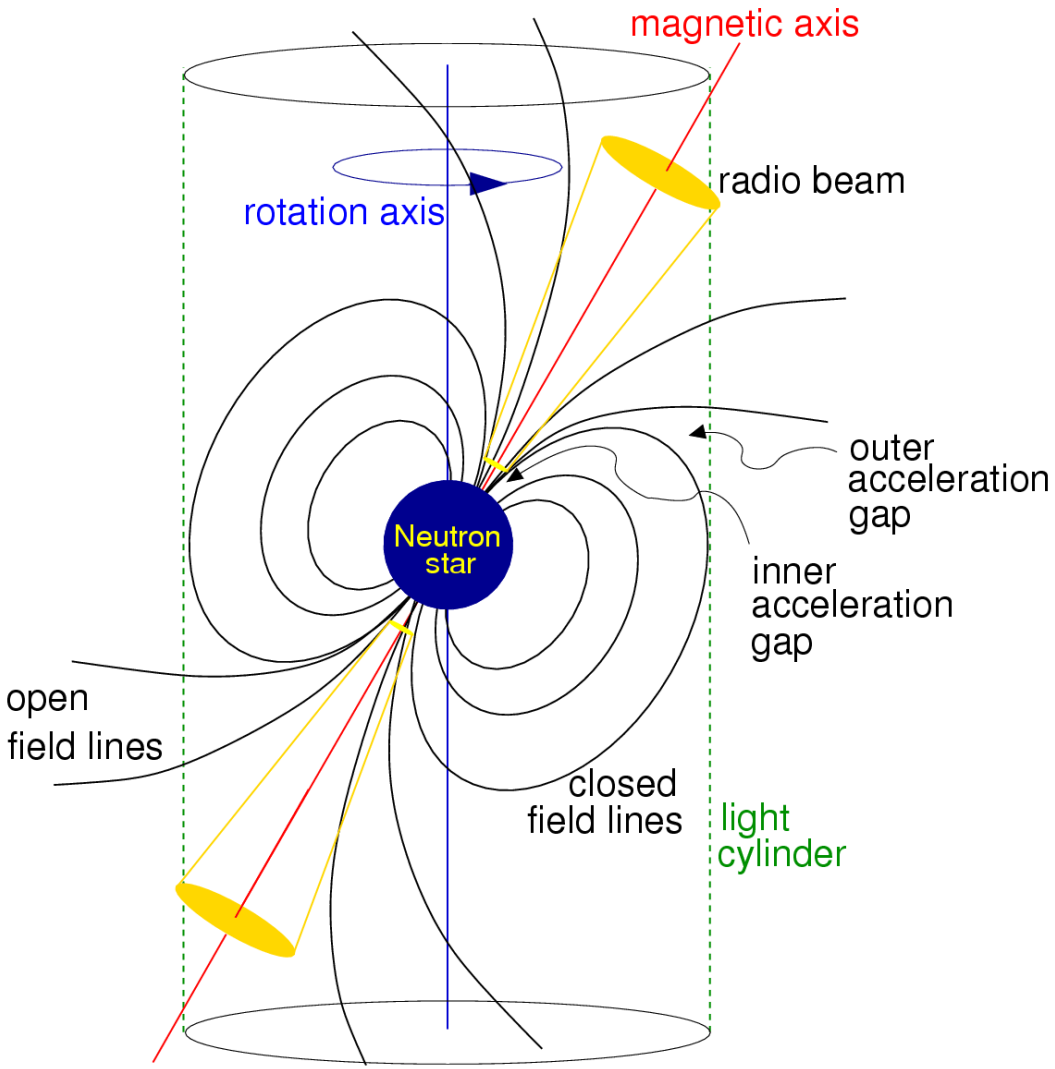
- Fontes de Ondas Gravitacionais
- Detecção de Ondas Gravitacionais
- Objetos compactos
- Relatividade Geral Algébrica e Numérica

Teorias alternativas à Relatividade Geral

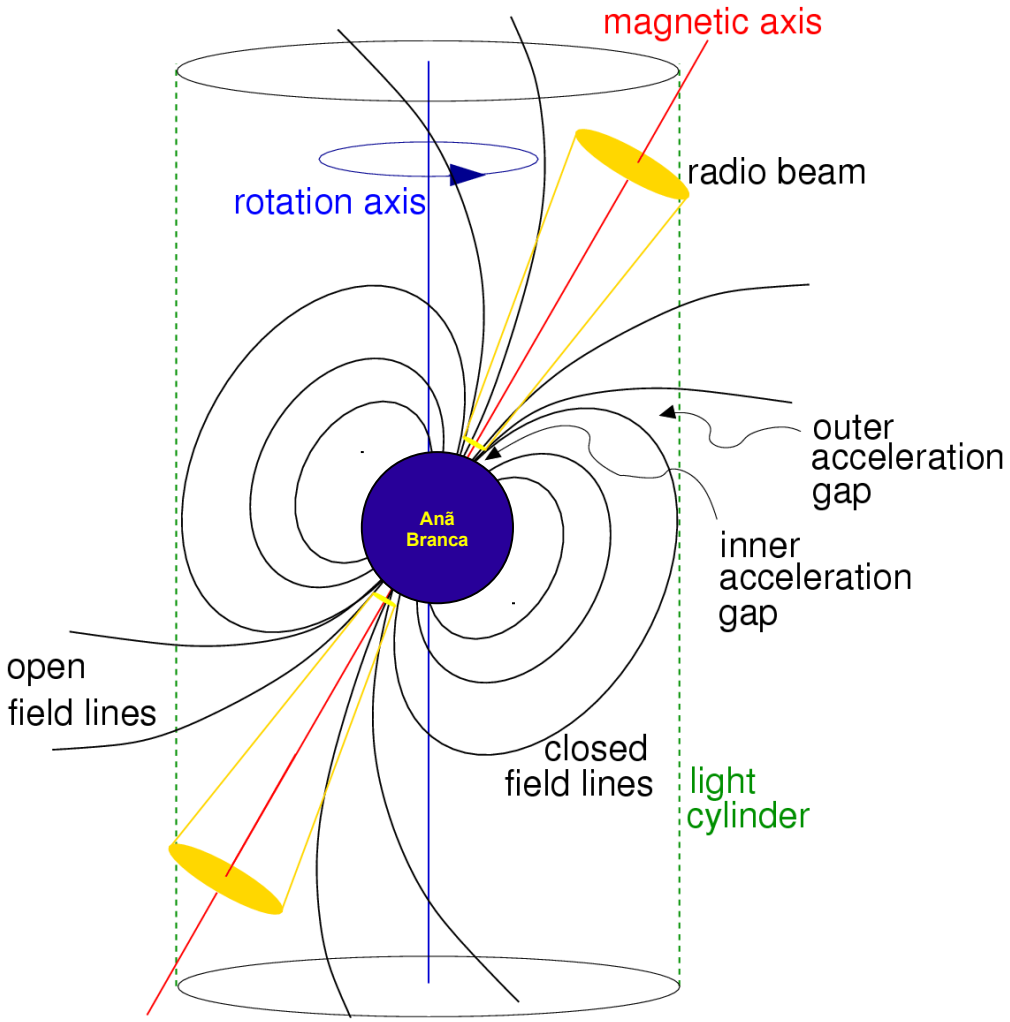
Algumas motivações:

- Expansão acelerada
- Singularidades
- RG não é quantizável

Fontes de Ondas Gravitacionais (OGs)



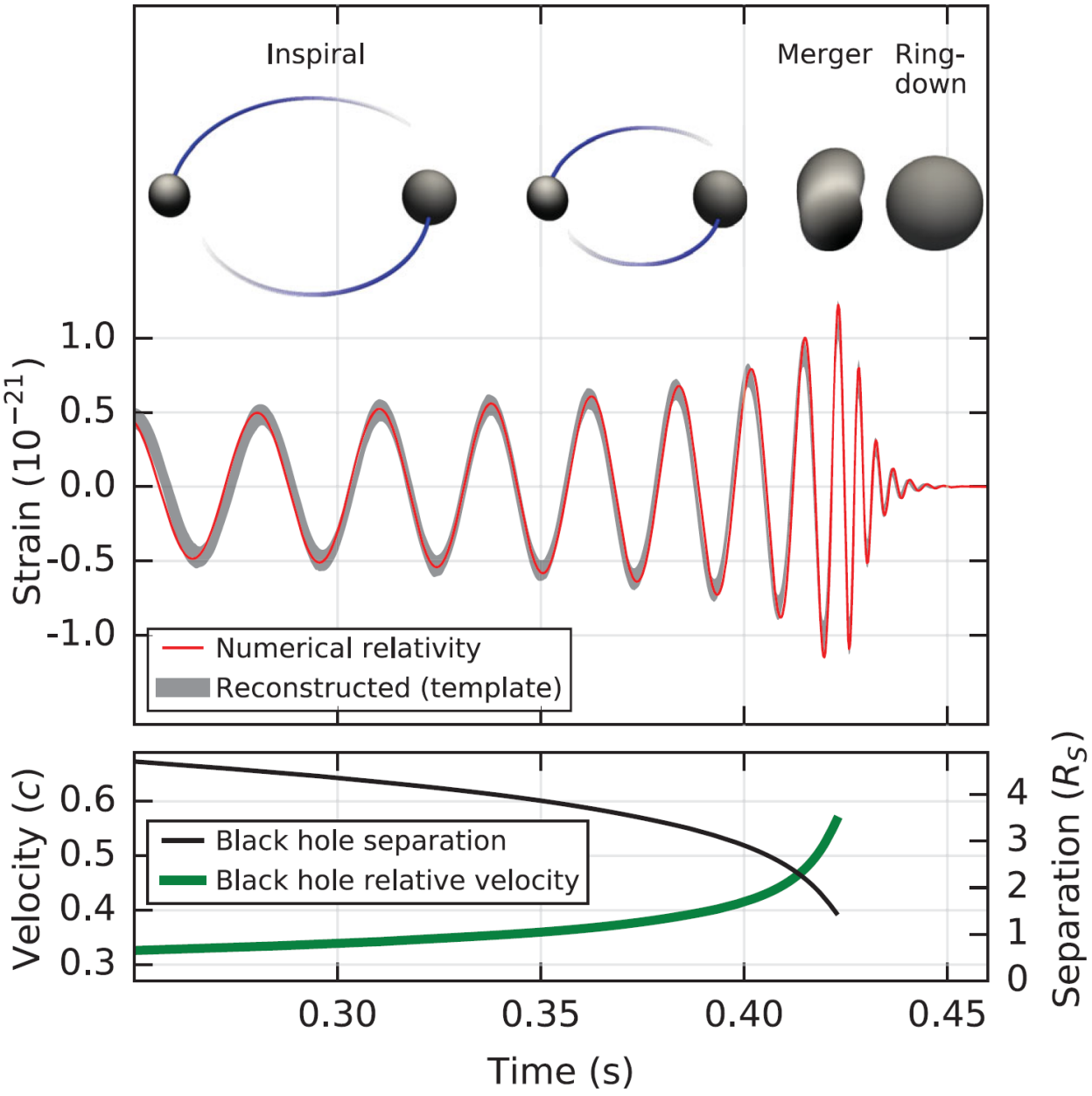
Pulsar = estrela de nêutrons em rotação



?

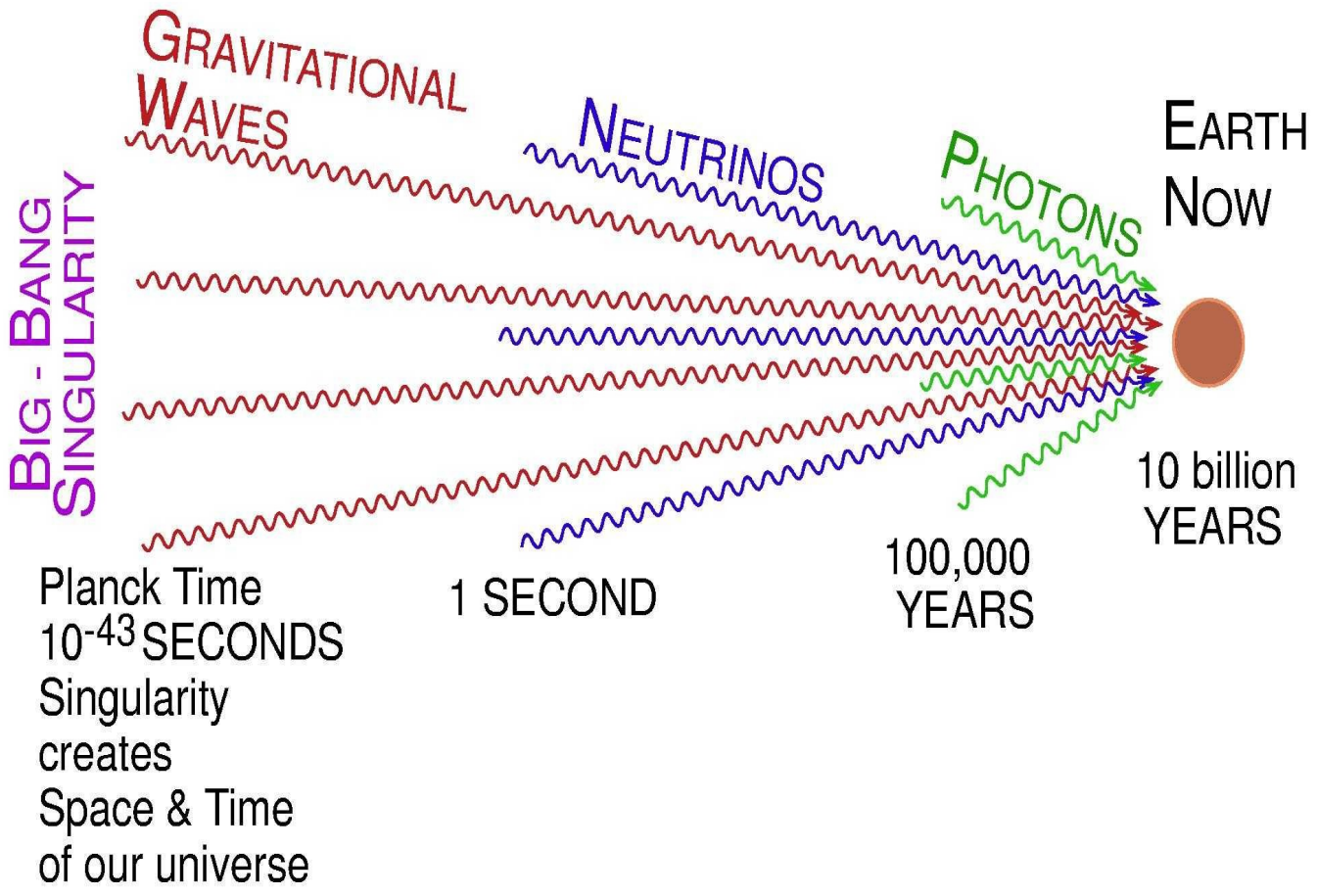
Existem pulsares de anãs brancas?

Perguntem ao Felipe!



(http://journals.aps.org/prl/pdf/10.1103/PhysRevLett.116.061102)

- Big-Bang Birth of Universe

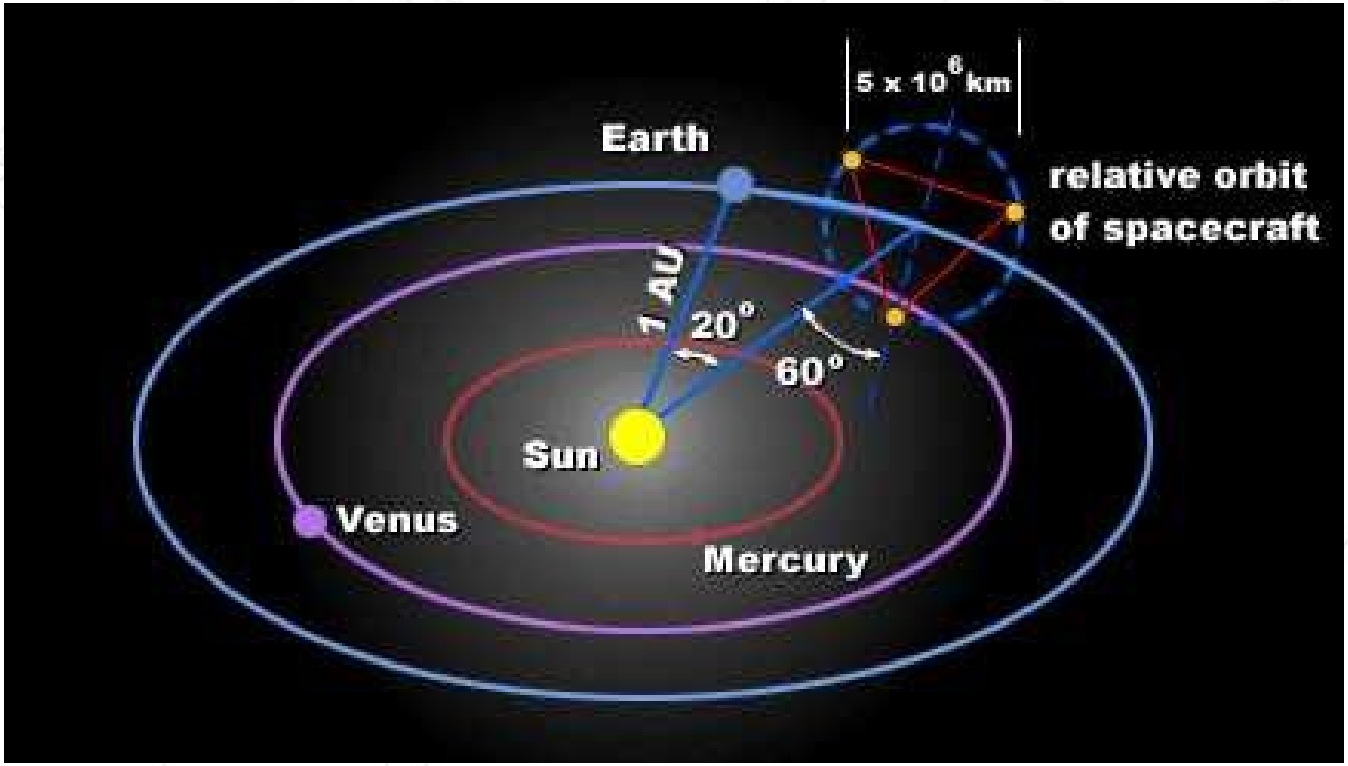


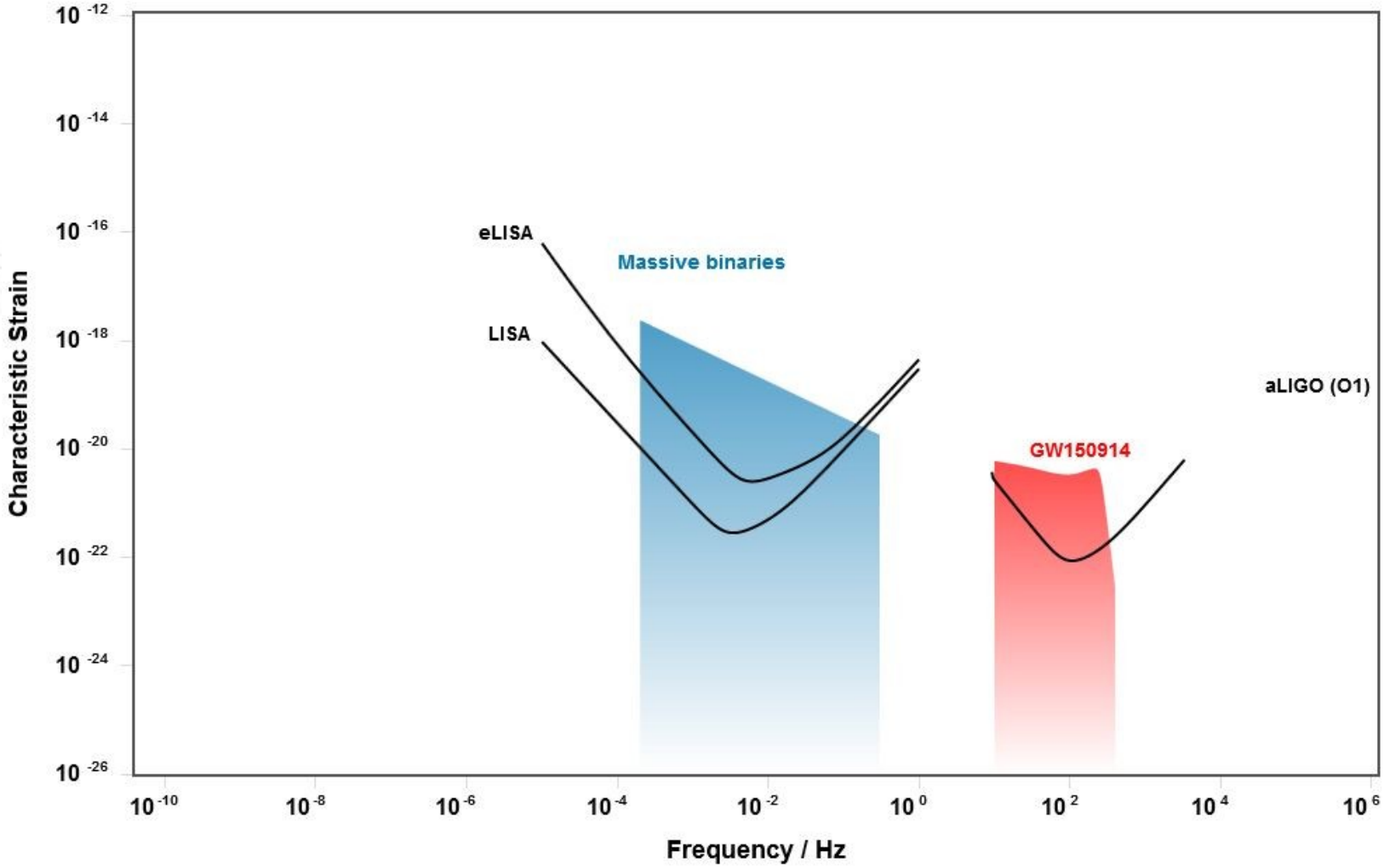
Trabalhos desenvolvidos e em desenvolvimento …

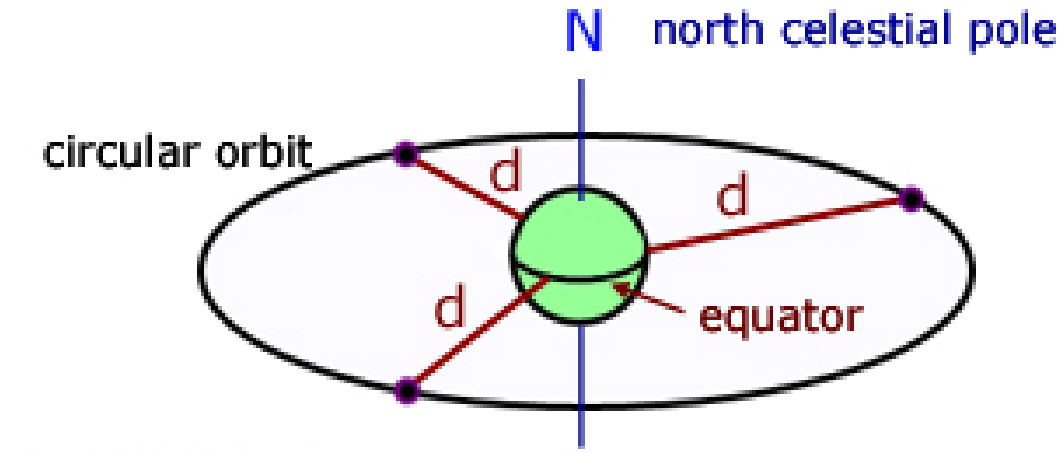
Relatividade Geral Algébrica e Numérica na formulação 2+2 (ex-estudante: Carlos Eduardo)

gLISA (rebatizado de AMIGO):
Uma alternativa ao (e)LISA
(c/ Massimo Tinto e Márcio Alves)

Condições de energia em Teorias Alternativas
(c/ Mariana Lima, Márcio Alves, Sandro e Fábio)

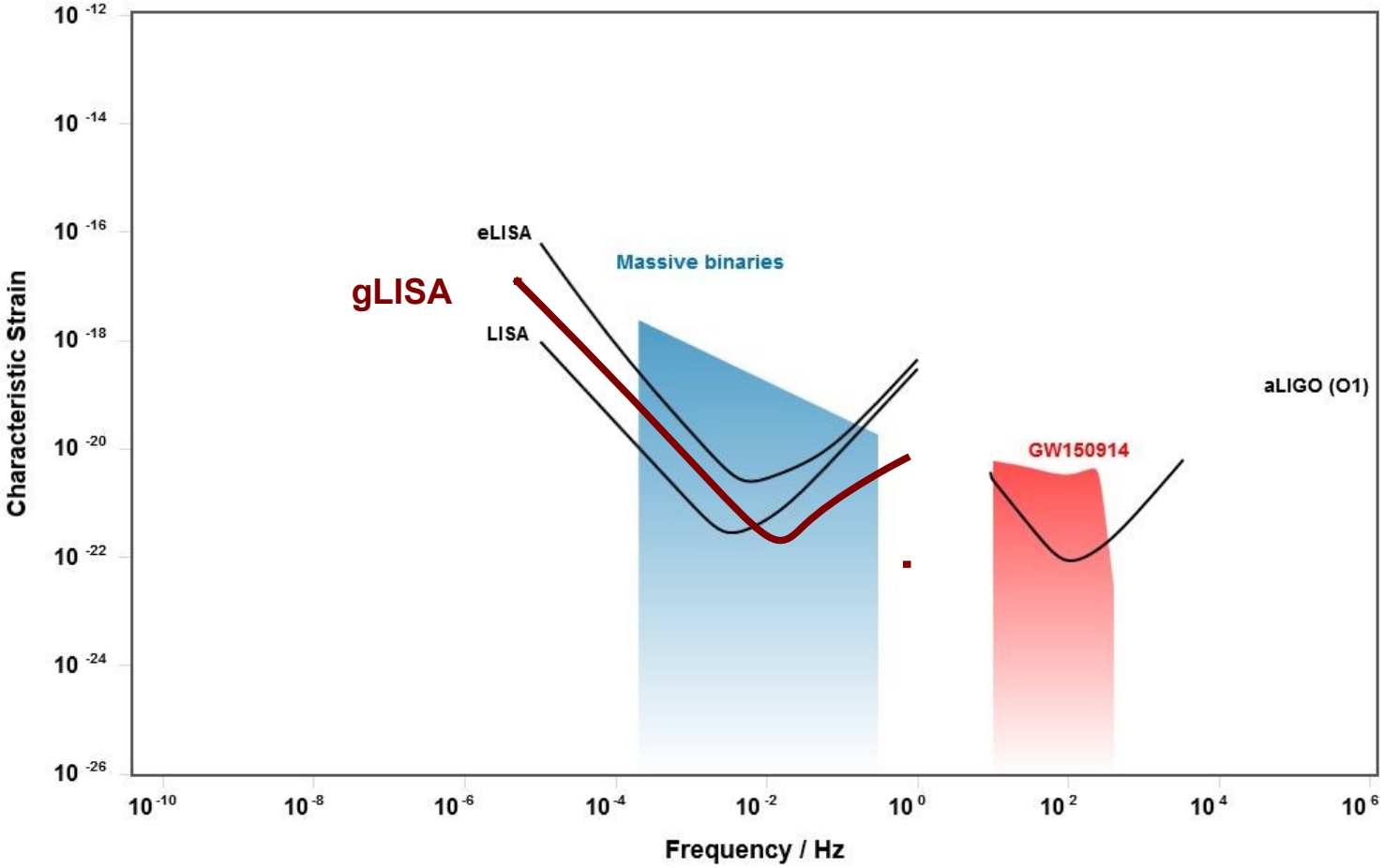

5 x 10^6 km
Earth
relative orbit
of spacecraft
1 AU
20°
60°
Sun
Venus
Mercury


Characteristic Strain
10 -12
10 -14
10 -16
10 -18
10 -20
10 -22
10 -24
10 -26
eLISA
LISA
Massive binaries
aLIGO (O1)
GW150914
10 -10
10 -8
10 -6
10 -4
10 -2
10 0
10 2
10 4
10 6
Frequency / Hz



d = 22,300 miles
(35,900 km)

period of satellite = 24 hours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10 2
10 4
10 6
Frequency / Hz

Trabalhos desenvolvidos e em desenvolvimento …

- Pulsars NS: OGs etc (Samantha e Jaziel)
- Pulsars WD: OGs (Felipe e Jaziel)
- AE Aqr (c/ Cláudia et al)
- Fundos de OGs de origem cosmológica em teorias alternativas (Hemily Fortes, Rafael Messi e Márcio Alves)
- Etc …. (Hemily, Rafael, Márcio, etc ...)

Artigos Publicados

Eur. Phys. J. C (2018) 78:710
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THE EUROPEAN PHYSICAL JOURNAL C

CrossMark

Regular Article - Theoretical Physics

Cosmological constant constraints from observation-derived energy condition bounds and their application to bimetric massive gravity

M. E. S. Alves[1,a], F. C. Carvalho[2,b], J. C. N. de Araujo[3,c], M. Penna-Lima[4,5,6,d], S. D. P. Vitenti[7,8,e]

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THE EUROPEAN PHYSICAL JOURNAL C

Regular Article - Theoretical Physics

Reconstruction of energy conditions from observations and implications for extended theories of gravity

M. Penna-Lima[1,2,a], S. D. P. Vitenti[3,4,b], M. E. S. Alves[5,c], J. C. N. de Araujo[6,d], F. C. Carvalho[7,e]

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Accepted Paper

Primordial gravitational waves in Horndeski gravity

Phys. Rev. D

Rafael C. Nunes, Márcio E. S. Alves, and José C. N. de Araujo

Accepted 31 March 2019

ABSTRACT

ABSTRACT

We investigate the propagation of primordial gravitational waves within the context of the Horndeski theories, for this, we present a generalized transfer function quantifying the sub-horizon evolution of gravitational waves modes after they enter the horizon. We compare the theoretical prediction of the modified primordial gravitational waves spectral density with the aLIGO, Einstein telescope, LISA, gLISA and DECIGO sensitivity curves. Assuming reasonable and different values for the free parameters of the theory (in agreement with the event GW170817 and stability conditions of the theory), we note that the gravitational waves amplitude can vary significantly in comparison with general relativity. We find that in some cases the gravitational primordial spectrum can cross the sensitivity curves for DECIGO detector with the maximum frequency sensitivity to the theoretical predictions around 0.05 - 0.30 Hz. From our results, it is clear that the future generations of space based interferometers can bring new perspectives to probing modifications in general relativity.

FIM