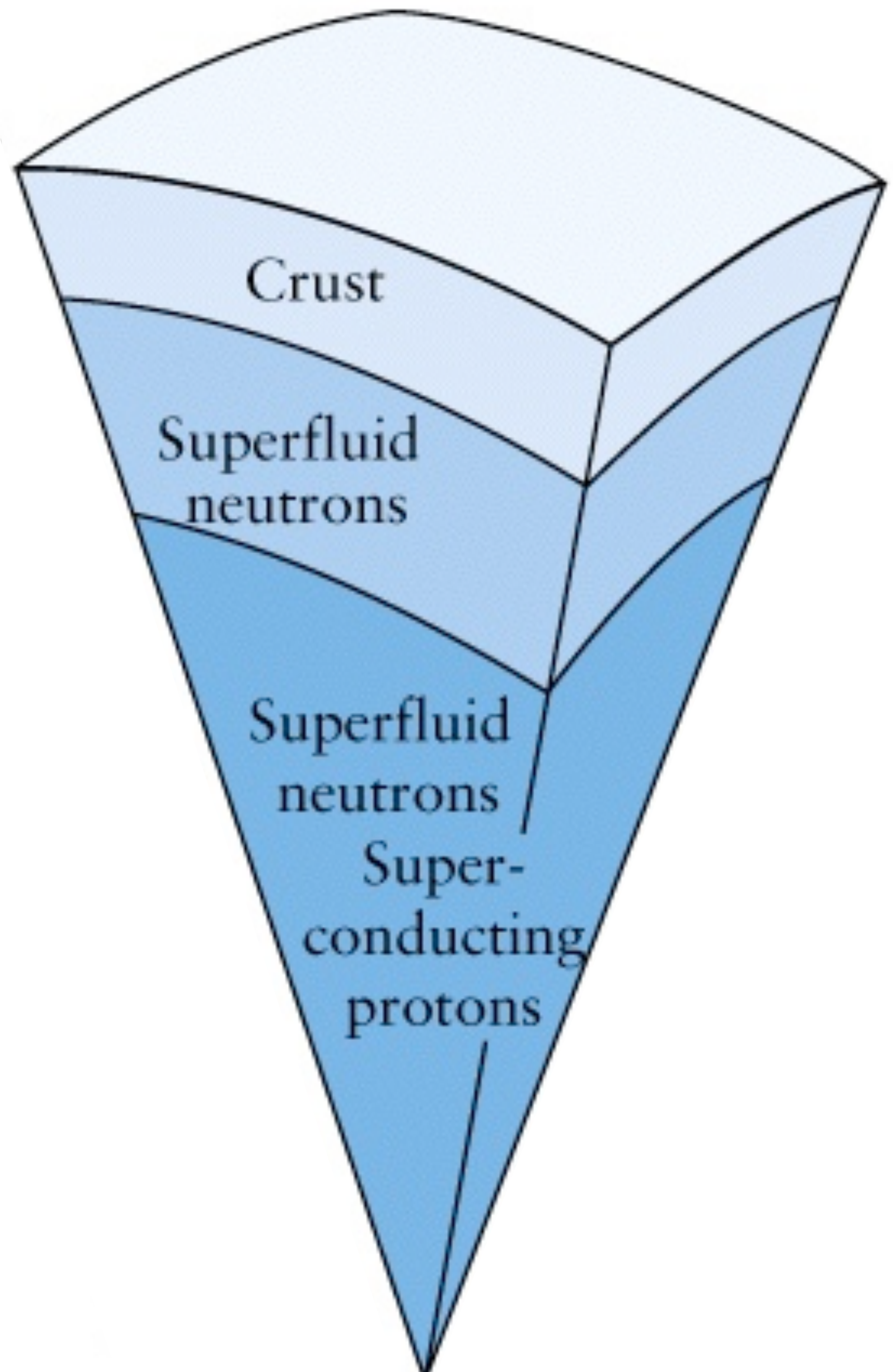
Spin noise

Paul Lasky

Melatos, Ravi, Hobbs

Greenstein (1970); Nature

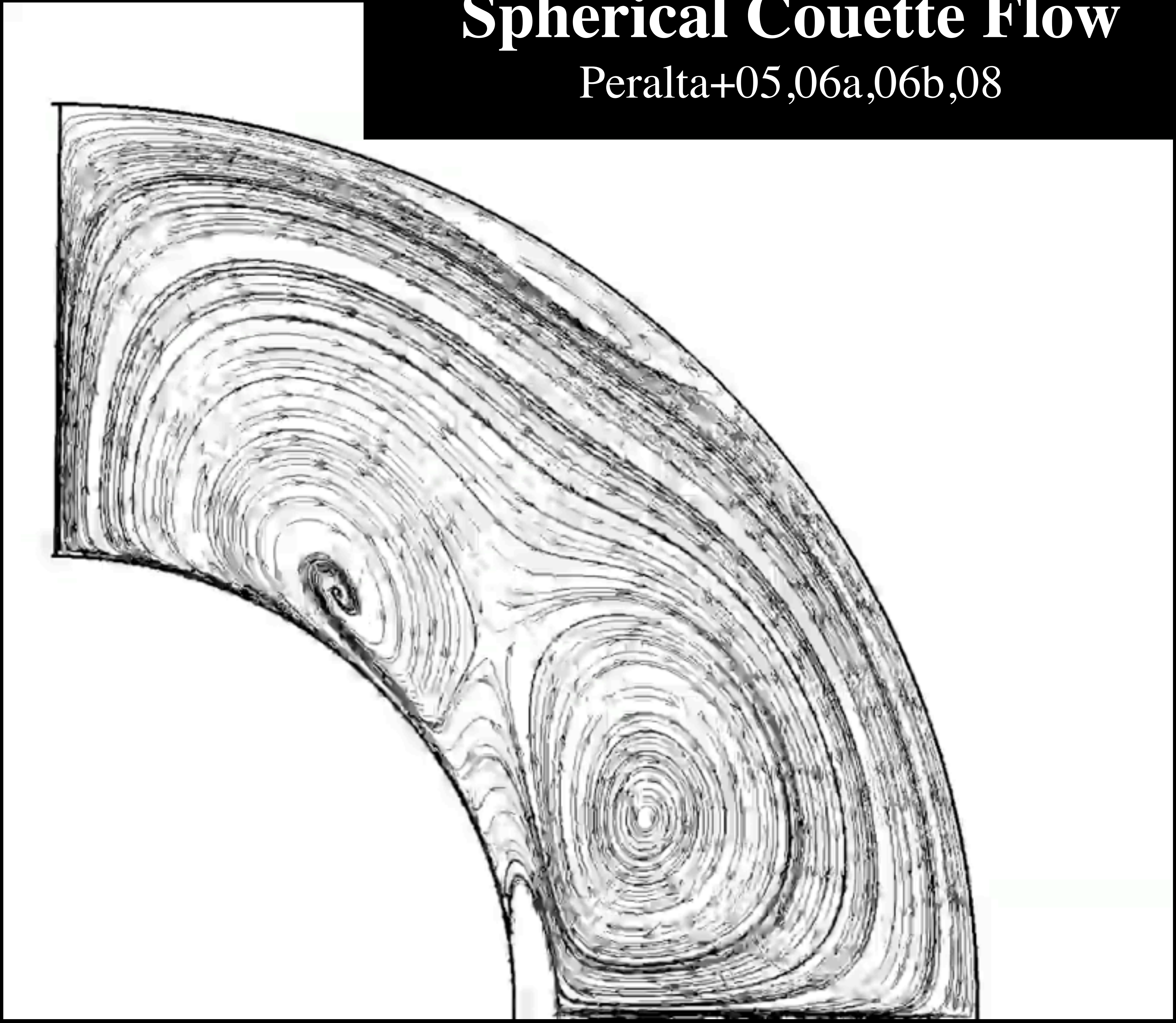
Abstract: The neutron superfluid in most neutron stars should be in a highly turbulent state. If so, this turbulence drastically alters its rotational properties.



http://www.ualberta.ca/~pogosyan

Spherical Couette Flow

Peralta+05,06a,06b,08



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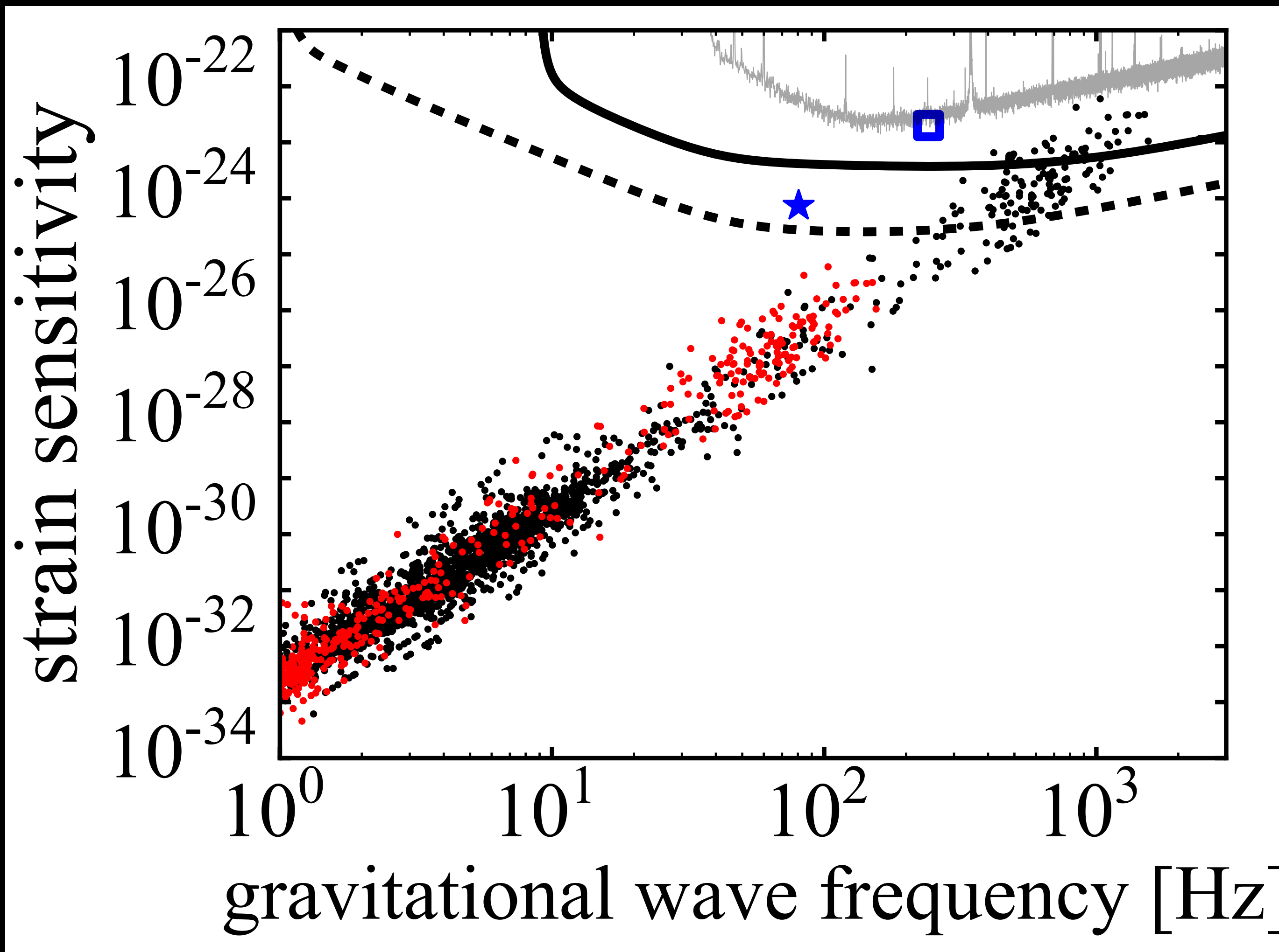
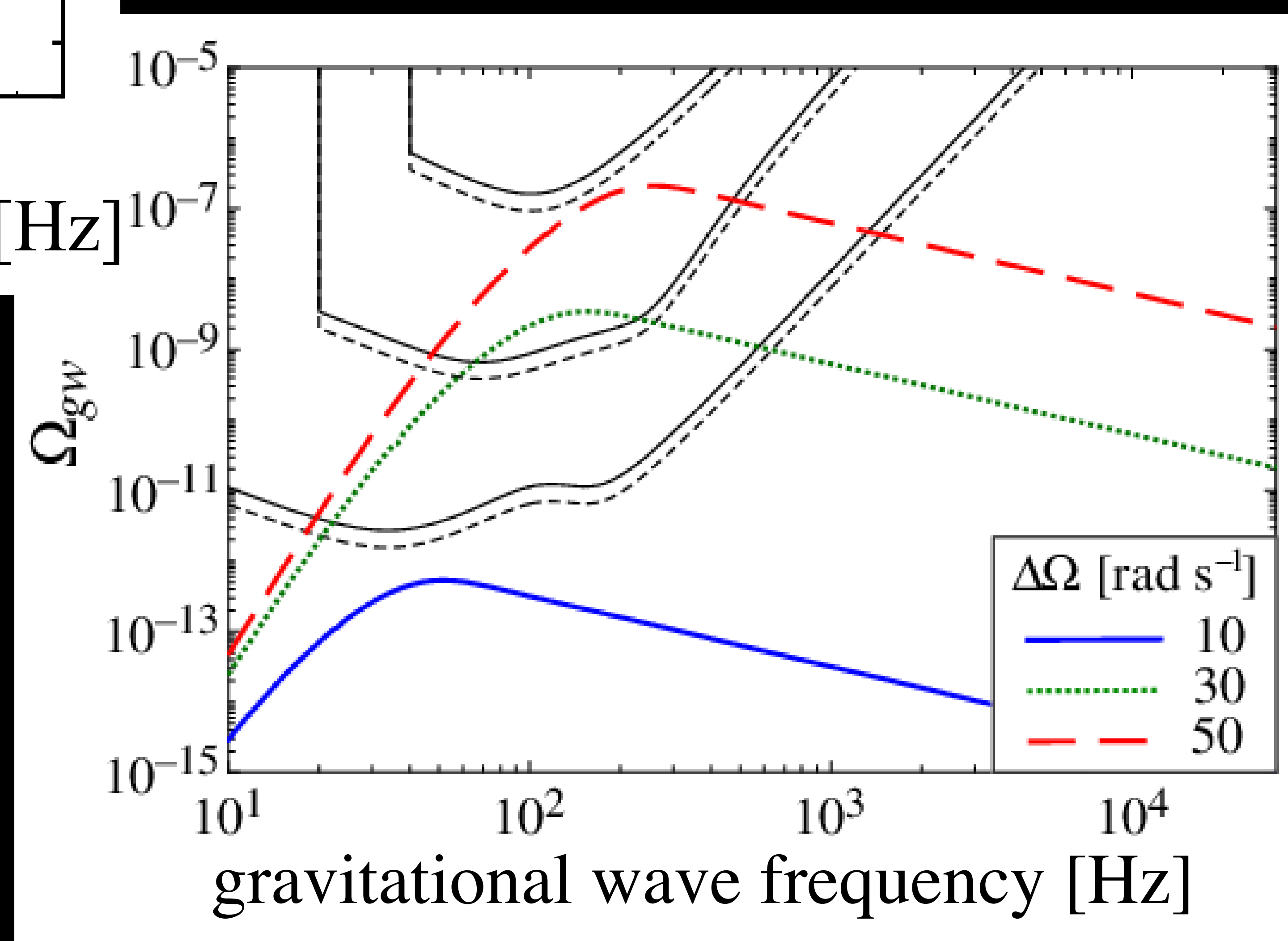
Parenthetically (new LIGO source)



Melatos+ 2010; PDL+ 2013



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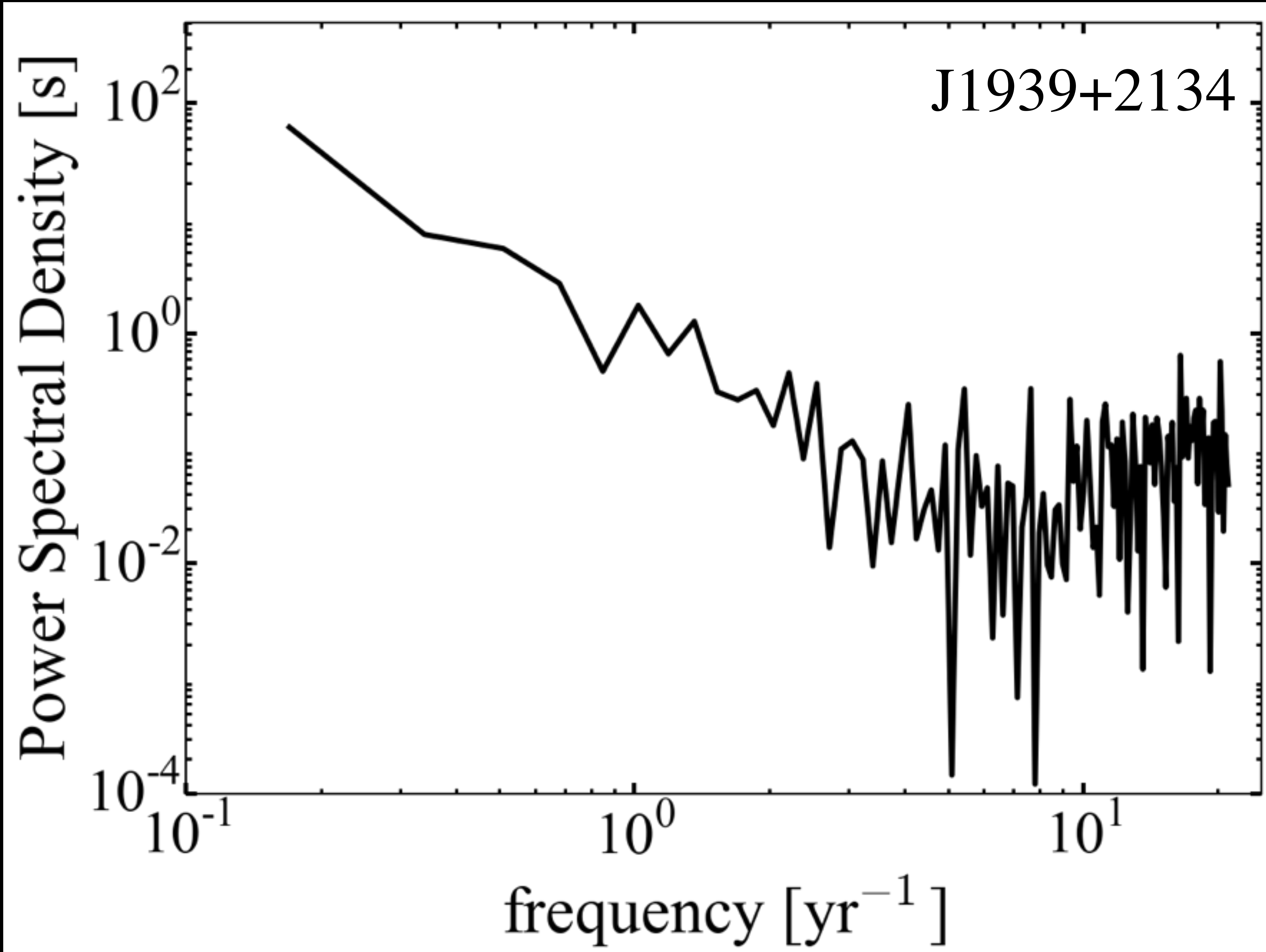
Greenstein (1970); Nature

‘My final point is a speculative one. When an uncooked egg rotates it does so irregularly. The yolk inside moves about erratically, and in order to conserve angular momentum the rotation rate of the shell must also fluctuate….

Greenstein (1970); Nature

‘My final point is a speculative one. When an uncooked egg rotates it does so irregularly. The yolk inside moves about erratically, and in order to conserve angular momentum the rotation rate of the shell must also fluctuate. The rotating turbulent neutron superfluid must exhibit something like the same phenomenon.’


J1939+2134
Power Spectral Density [s]
frequency [yr^{-1}]
10^{2}
10^{0}
10^{-2}
10^{-4}
10^{-1}
10^{0}
10^{1}

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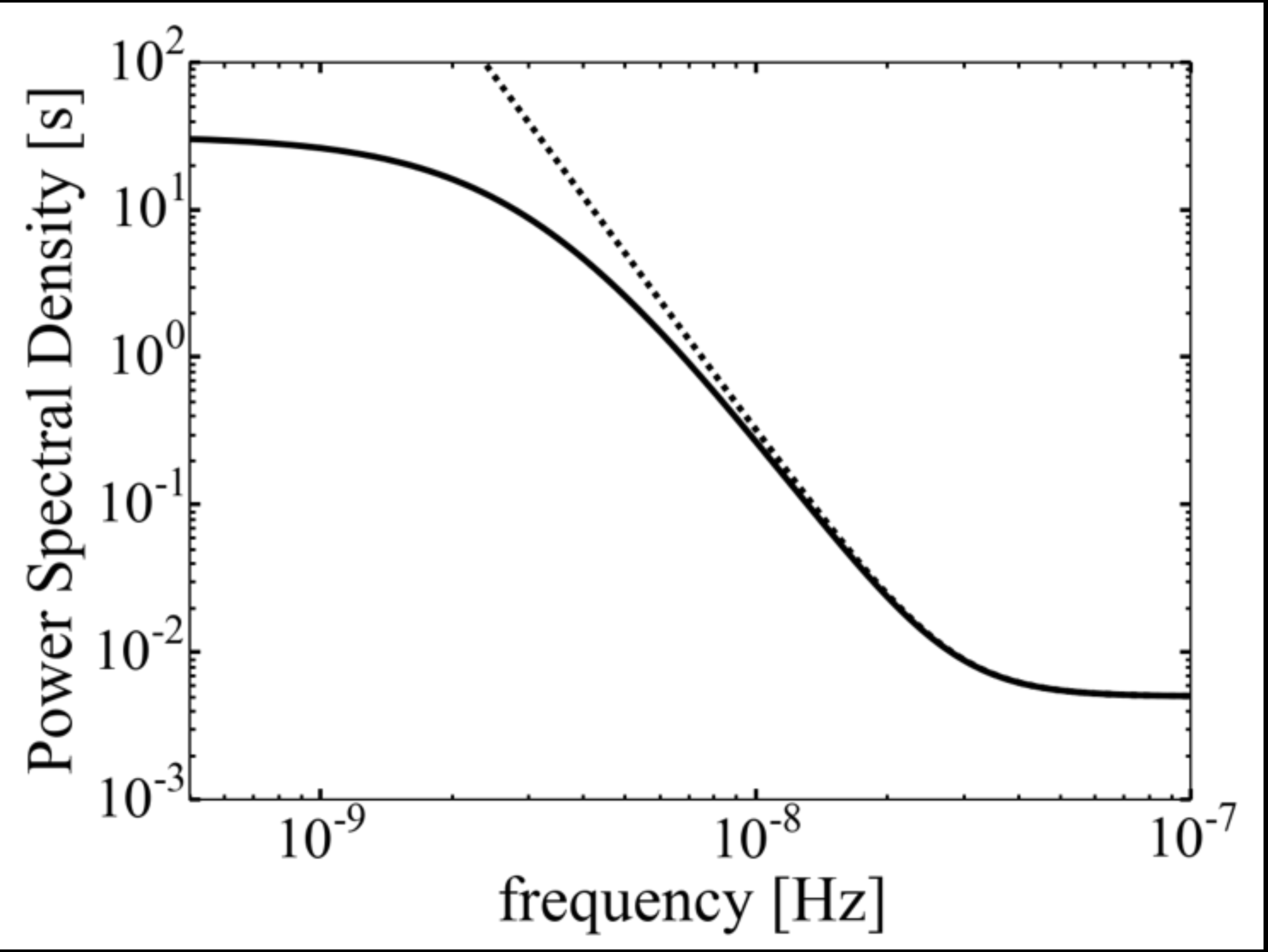
It turns out…

$$\Phi_{\rm TN} = \frac{A_{\rm TN}}{(1 + f^2/f_c^2)^{q/2}}$$



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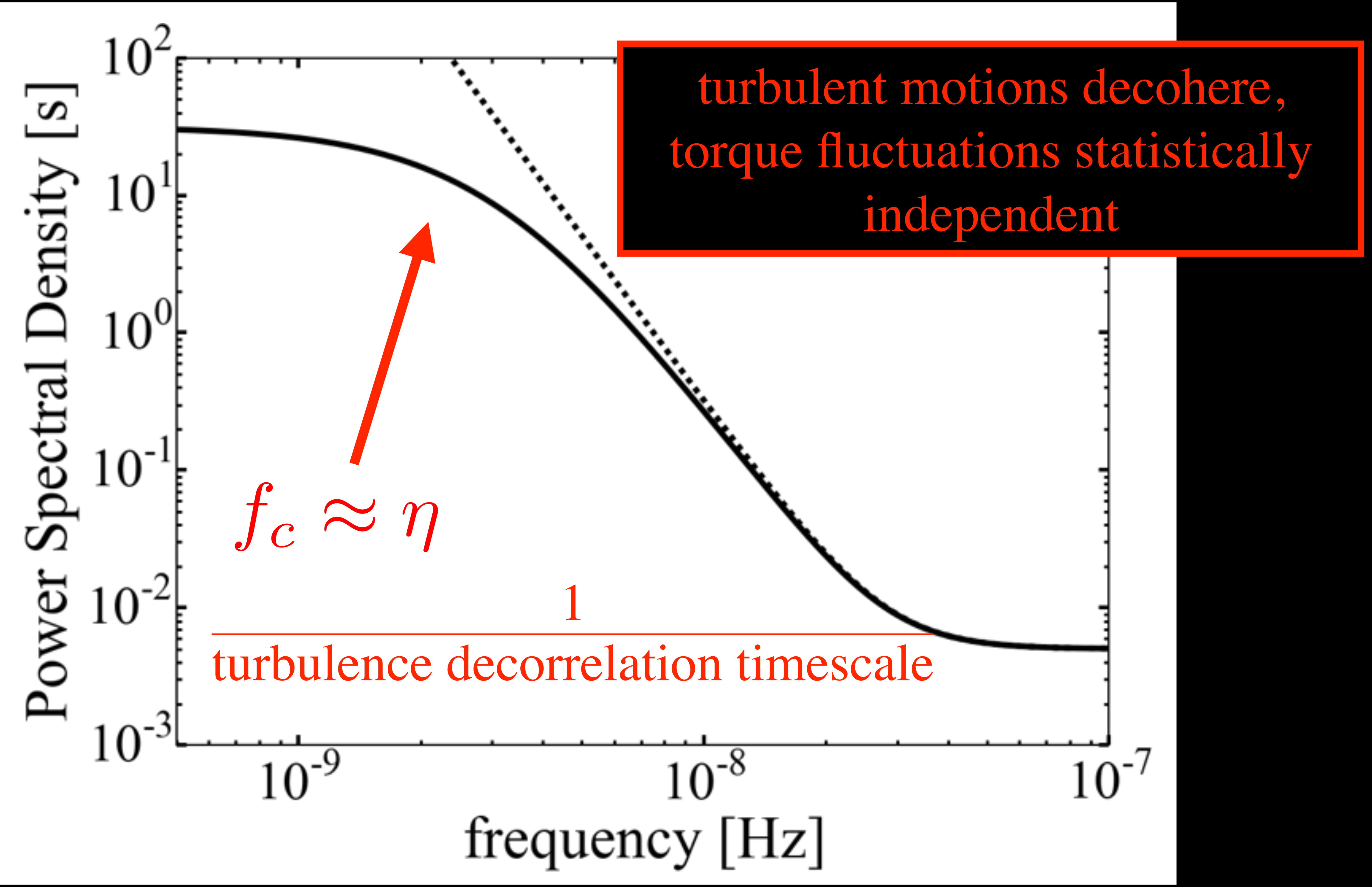
It turns out…

$$\Phi_{\rm TN} = \frac{A_{\rm TN}}{(1 + f^2/f_c^2)^{q/2}}$$



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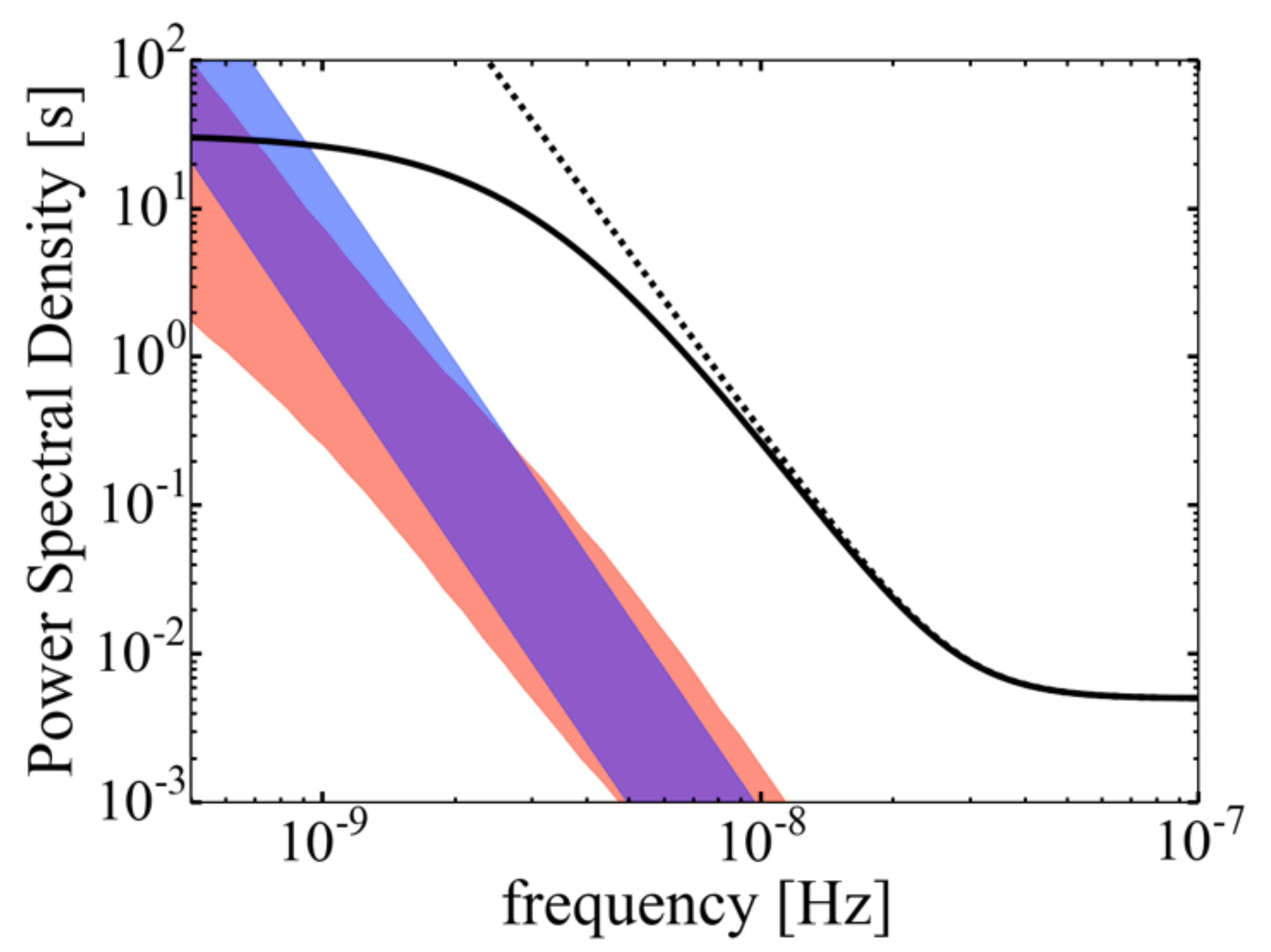
It turns out…

$$\Phi_{\mathrm{TN}} = \frac{A_{\mathrm{TN}}}{(1 + f^2/f_c^2)^{q/2}}$$



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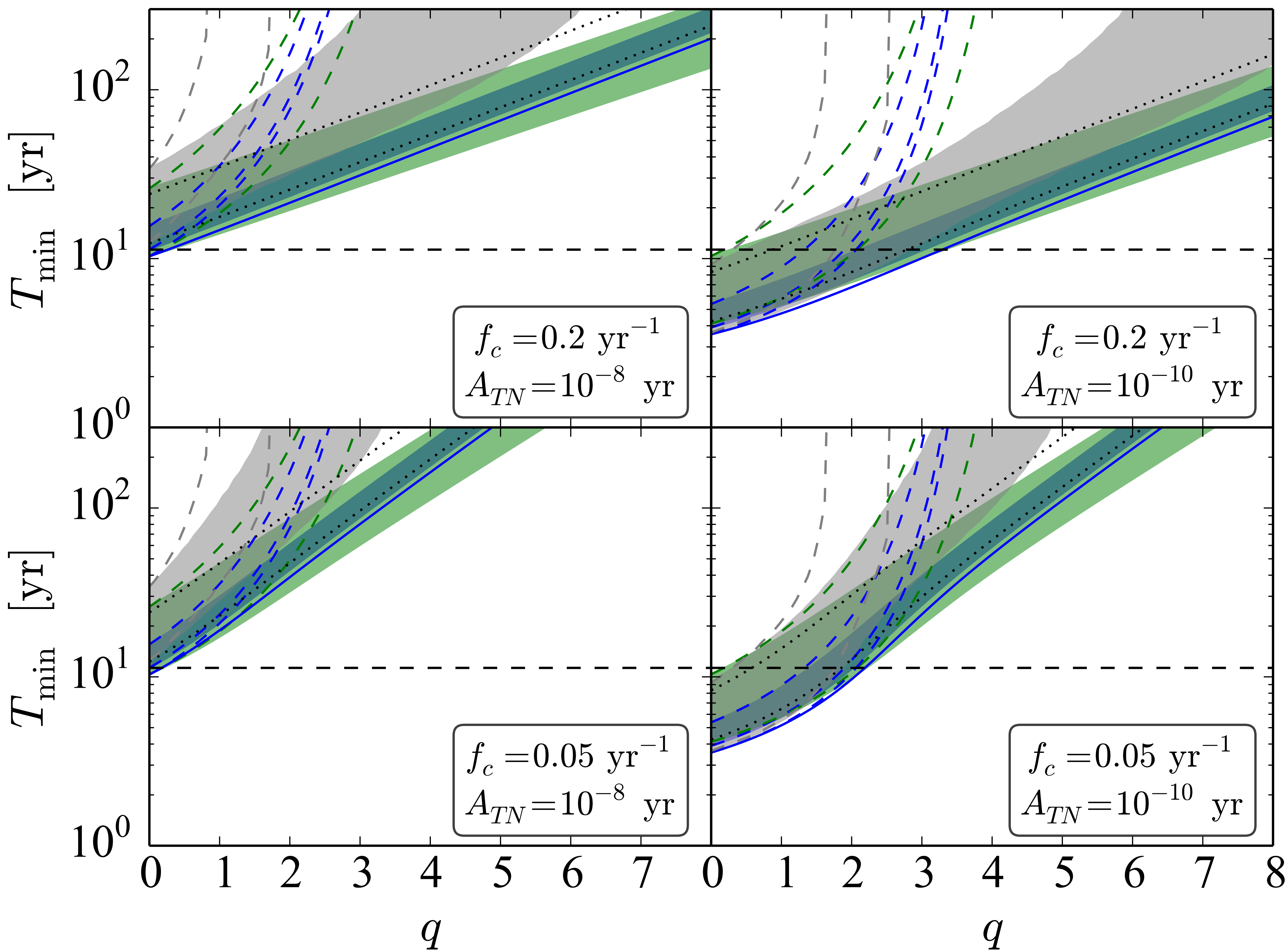
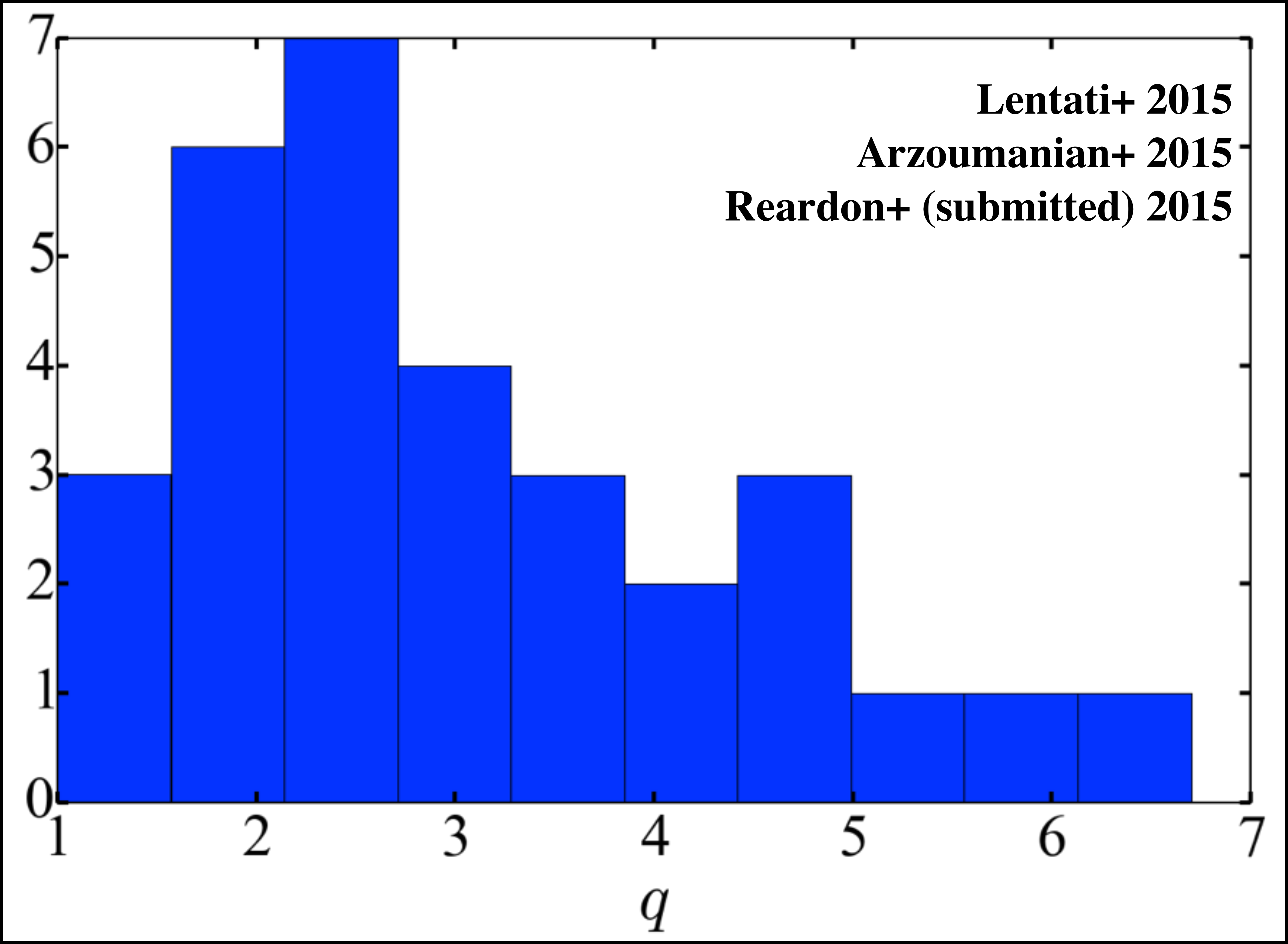
Can quantify how this changes a red pulsar's sensitivity to gravitational waves

see PDL, Melatos, Ravi & Hobbs 2015



$T_{\rm min}$ [yr]
10^0
10^1
10^2
$f_c = 0.2$ yr^{-1}
$A_{TN} = 10^{-8}$ yr
$f_c = 0.2$ yr^{-1}
$A_{TN} = 10^{-10}$ yr
$f_c = 0.05$ yr^{-1}
$A_{TN} = 10^{-8}$ yr
$f_c = 0.05$ yr^{-1}
$A_{TN} = 10^{-10}$ yr
0 1 2 3 4 5 6 7 8
q


Lentati+ 2015
Arzoumanian+ 2015
Reardon+ (submitted) 2015
0
1
2
3
4
5
6
7
1
2
3
4
5
6
7
q

Paul Lasky

‘So, Paul, what is the spectral index?’

Paul Lasky

‘So, Paul, what is the spectral index?’

‘Well **stupid,** it’s obviously related to the two-point decorrelation function of the velocity of the superfluid’

Paul Lasky

‘So, Paul, what <u>is</u> the spectral index?’

‘Well **stupid,** it’s obviously related to the two-point decorrelation function of the velocity of the superfluid’

‘huh…’

Paul Lasky

‘So, Paul, what <u>is</u> the spectral index?’

‘Well **stupid,** it’s obviously related to the two-point decorrelation function of the velocity of the superfluid’

‘huh…’

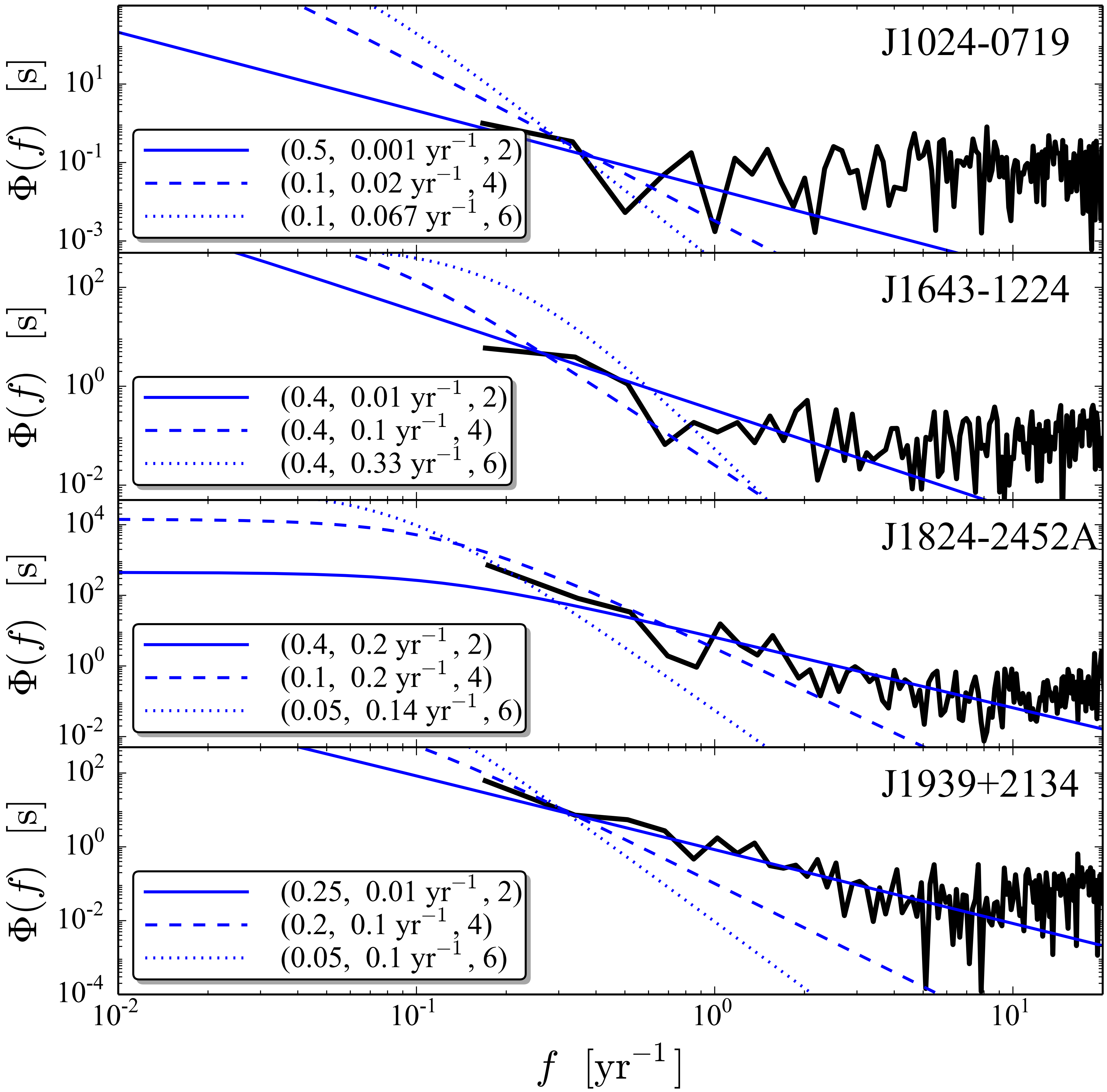
‘… we don’t know’

backup slides

Conclusions:

- We don’t understand spin noise
  (but we’re trying…)

- Let’s look for plateau’s!
  (work in progress using PAL2)



J1024-0719
(0.5, 0.001 yr^{-1}, 2)
(0.1, 0.02 yr^{-1}, 4)
(0.1, 0.067 yr^{-1}, 6)
J1643-1224
(0.4, 0.01 yr^{-1}, 2)
(0.4, 0.1 yr^{-1}, 4)
(0.4, 0.33 yr^{-1}, 6)
J1824-2452A
(0.4, 0.2 yr^{-1}, 2)
(0.1, 0.2 yr^{-1}, 4)
(0.05, 0.14 yr^{-1}, 6)
J1939+2134
(0.25, 0.01 yr^{-1}, 2)
(0.2, 0.1 yr^{-1}, 4)
(0.05, 0.1 yr^{-1}, 6)
$\Phi(f)$ [s]
f [yr^{-1}]