



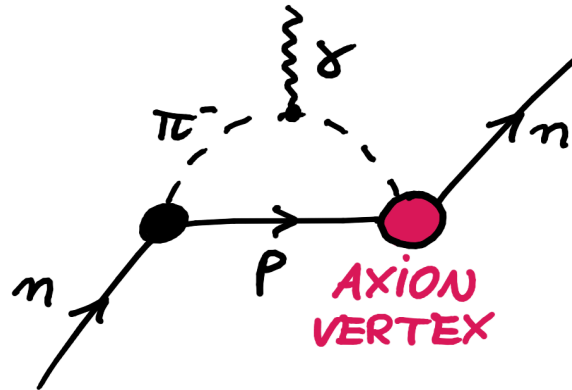
Looking for axions with nEDM experiments

Michał Rawlik on behalf of the nEDM collaboration

with: N. Ayres, M. Fairbairn, V. V. Flambaum, D. J. E. Marsh, Y. V. Stadnik

What is an axion?

- Axions tackle two problems of the modern physics:
 - The **strong CP problem** of QCD.
 - **Dark matter**, being a candidate therefor.
- Most searches focus on an axion coupling to photons.
- Recently, searching for a **gluon coupling** has been proposed:



Axion-induced nEDM oscillation

$$d_n(t) \approx 5.9 \times 10^{-22} C_G \left(\frac{10^{-22} \text{eV}}{m_a} \right) \left(\frac{10^{16} \text{GeV}}{f_a} \right) \cos(m_a t) e \cdot \text{cm}$$

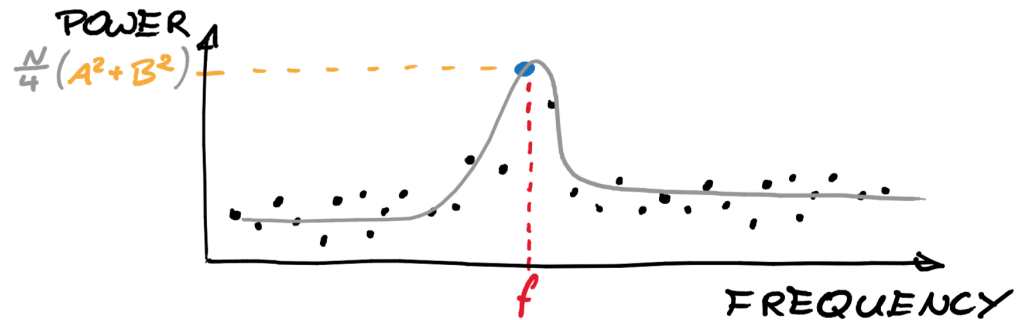
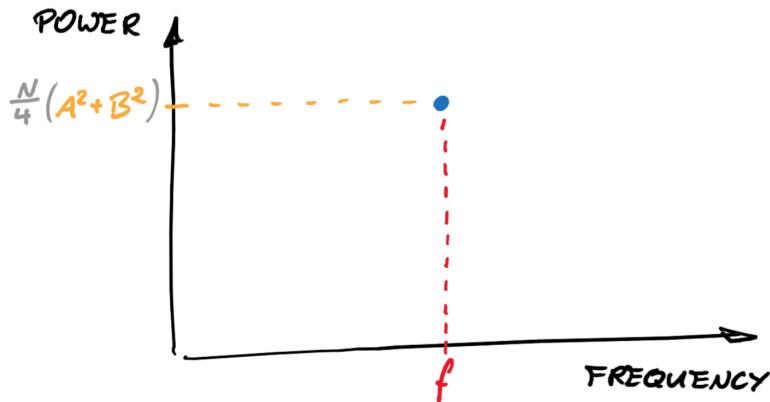
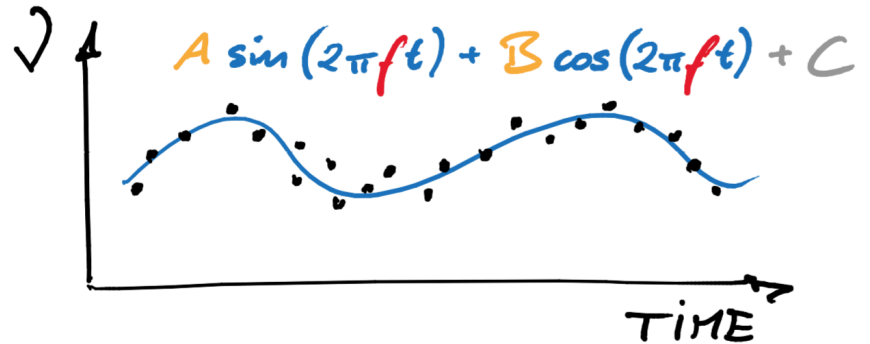
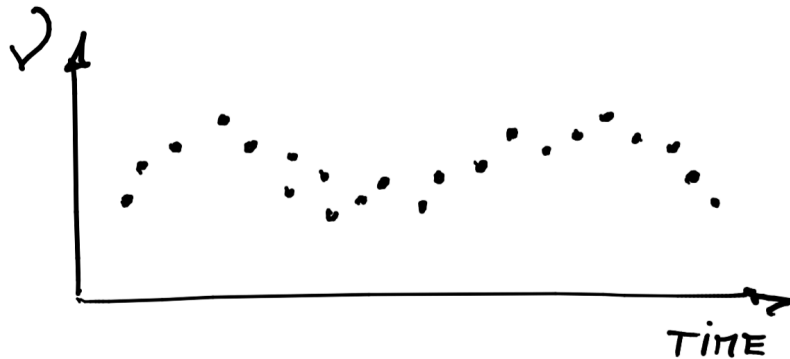
ILL & PSI
nEDM measurements:

$$h\nu = -2\vec{S} \cdot \left(\mu \vec{B} + d_n \vec{E} \right)$$

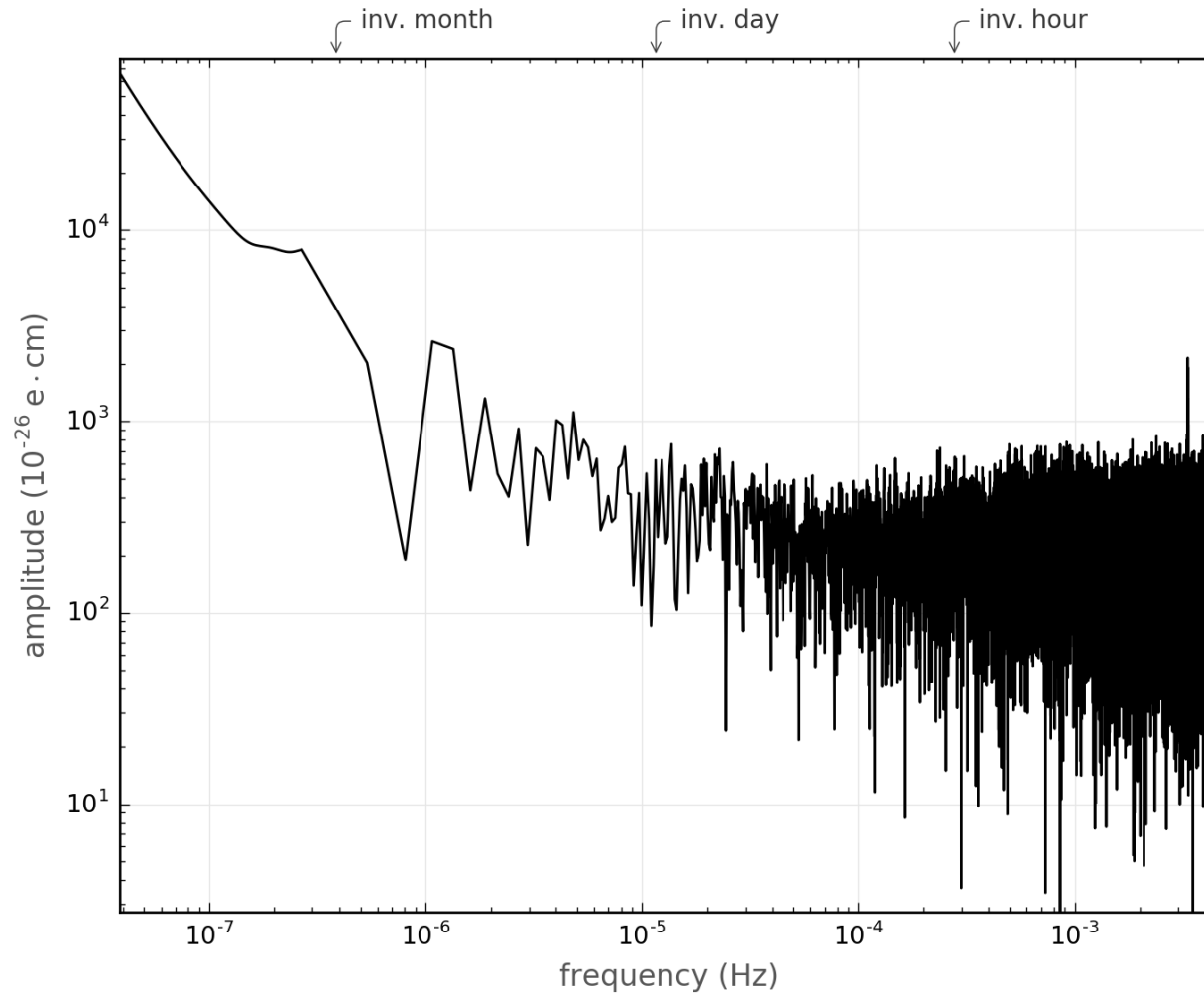
neutron precession frequency

If d_n oscillates, ν will oscillate too.

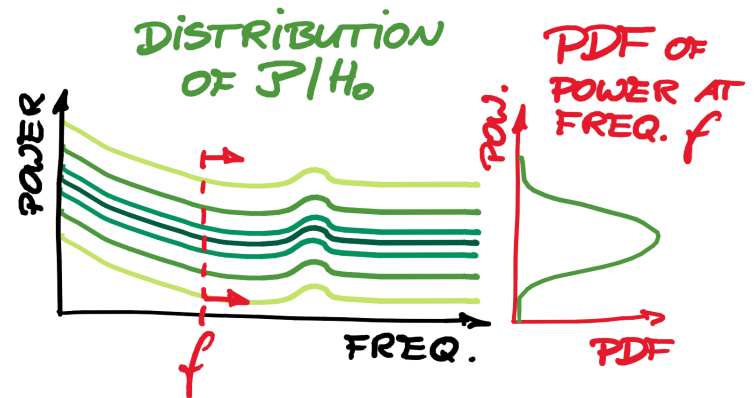
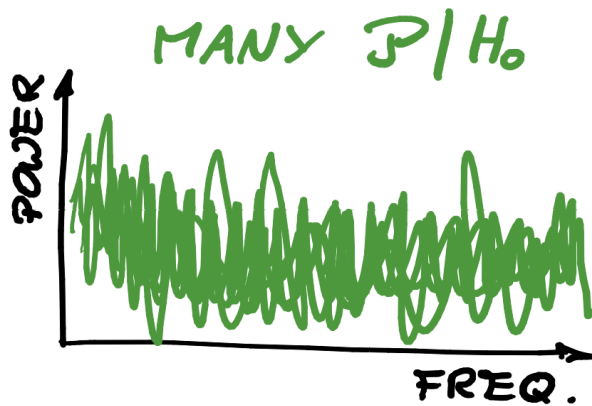
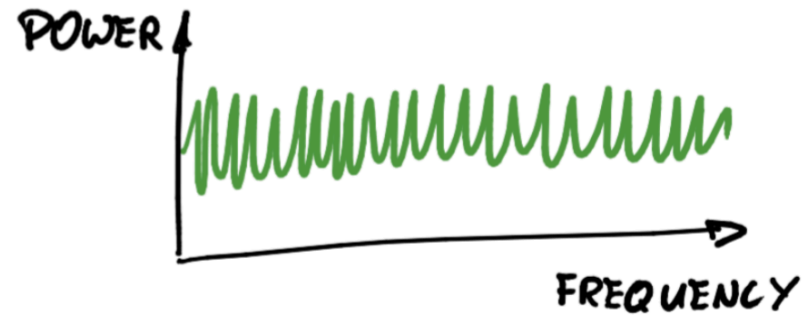
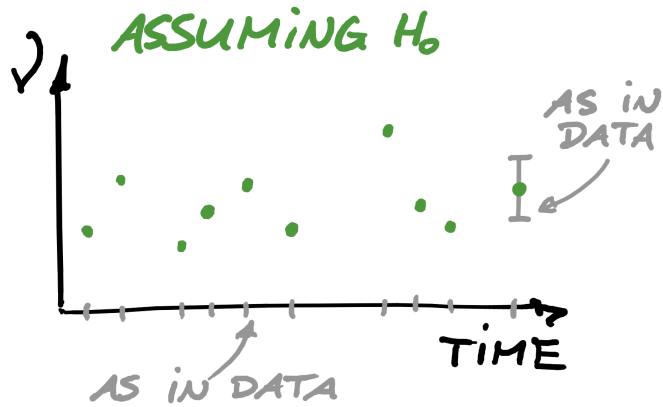
Least Squares Spectral Analysis (LSSA)



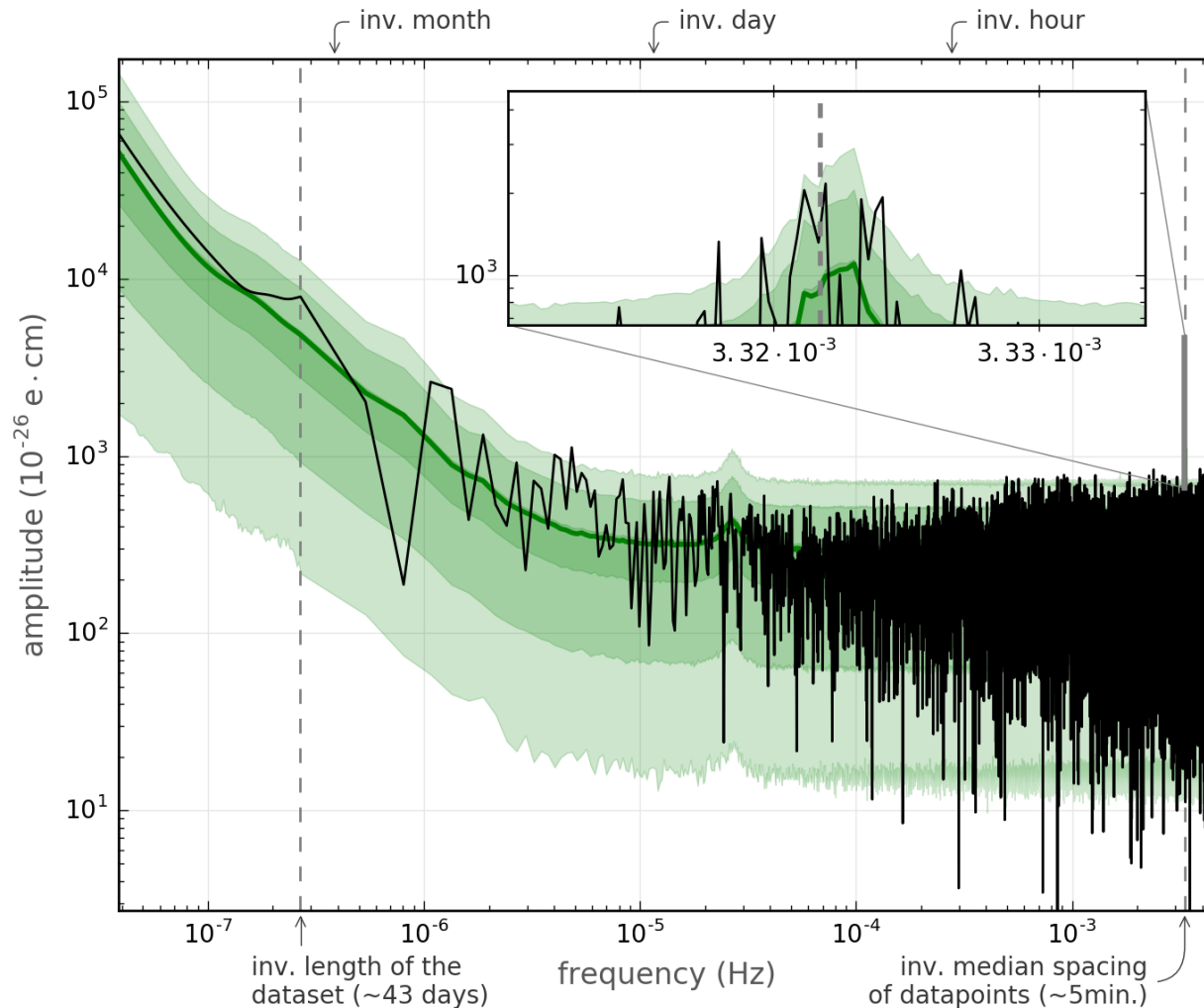
The Data Periodogram



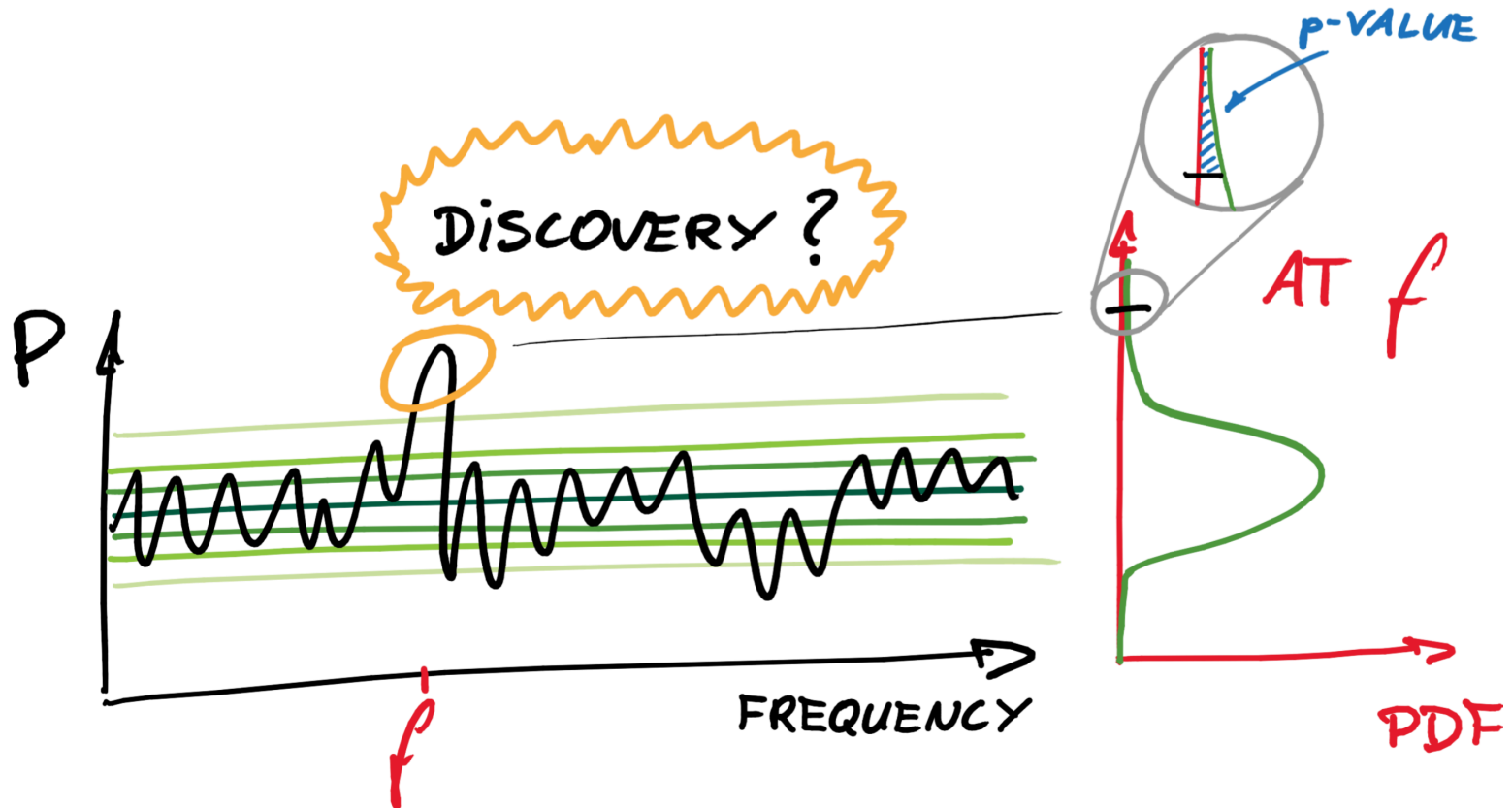
The Periodogram Under the Null Hypothesis



The Data Periodogram vs. the Null Hypothesis



The Null Hypothesis Test



The Look-Elsewhere Effect

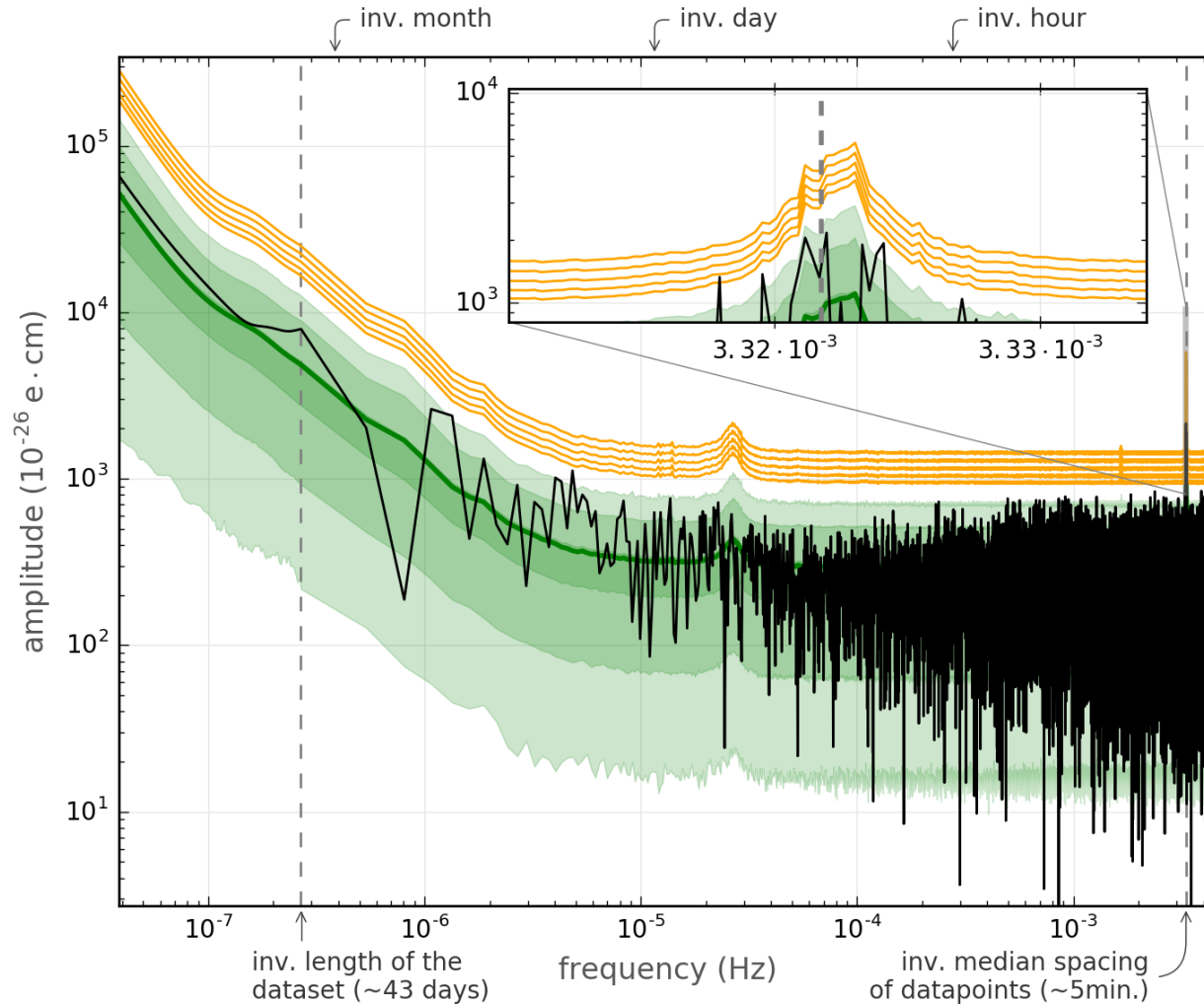
$$p_{\text{global}} = 1 - (1 - p_{\text{local}})^{\text{number of frequencies}}$$

number of frequencies = 1 000 000

p_{global} = 3-sigma level

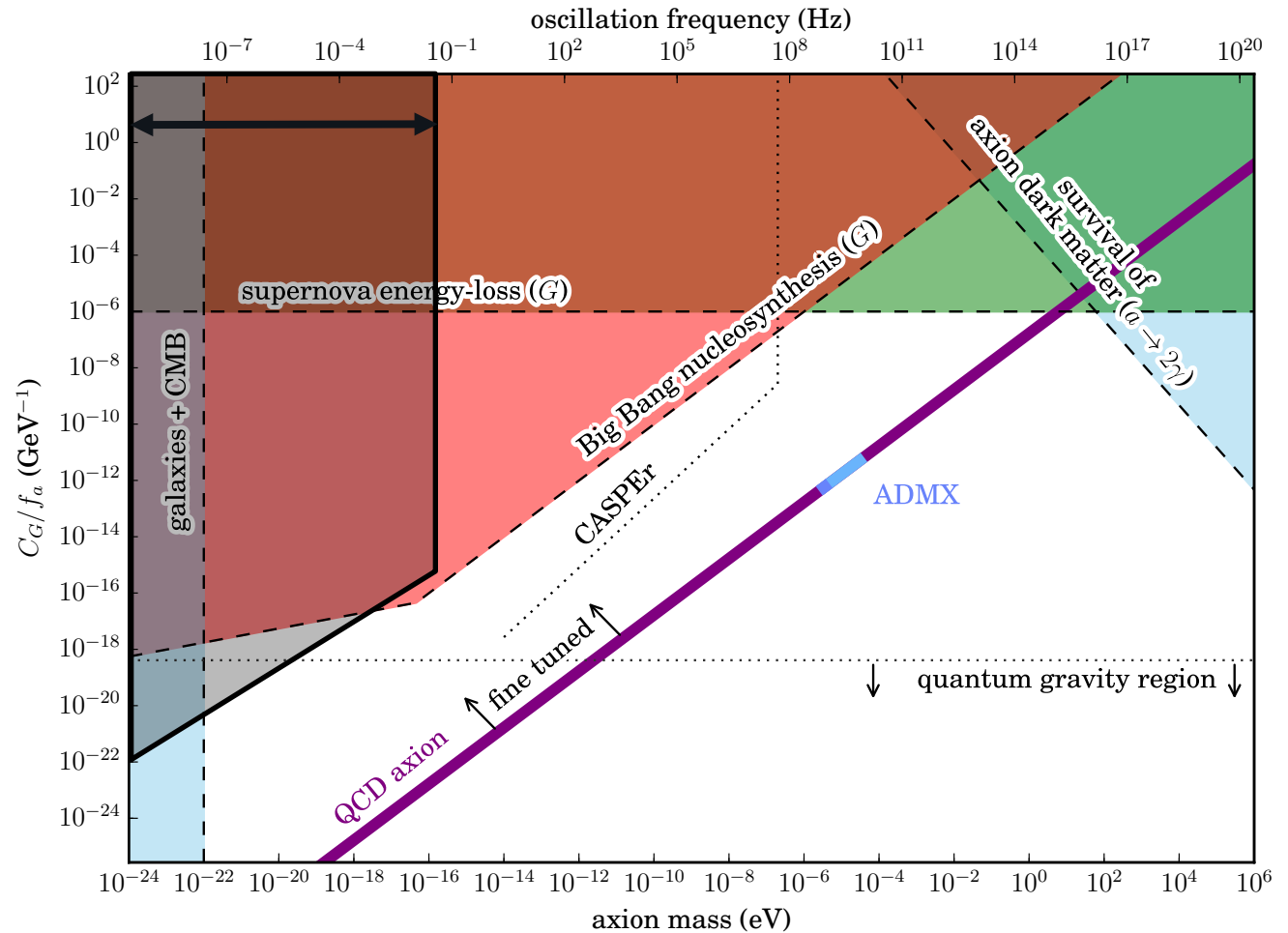
p_{local} = 6-sigma level

False-Alarm Thresholds



First Experimental Limits on the Axion-Gluon Coupling

We cover periods from minutes to decades.



Thank you for your attention!

Further reading:

D. J. E. Marsh, Phys. Rep. **643**, 1 (2016)

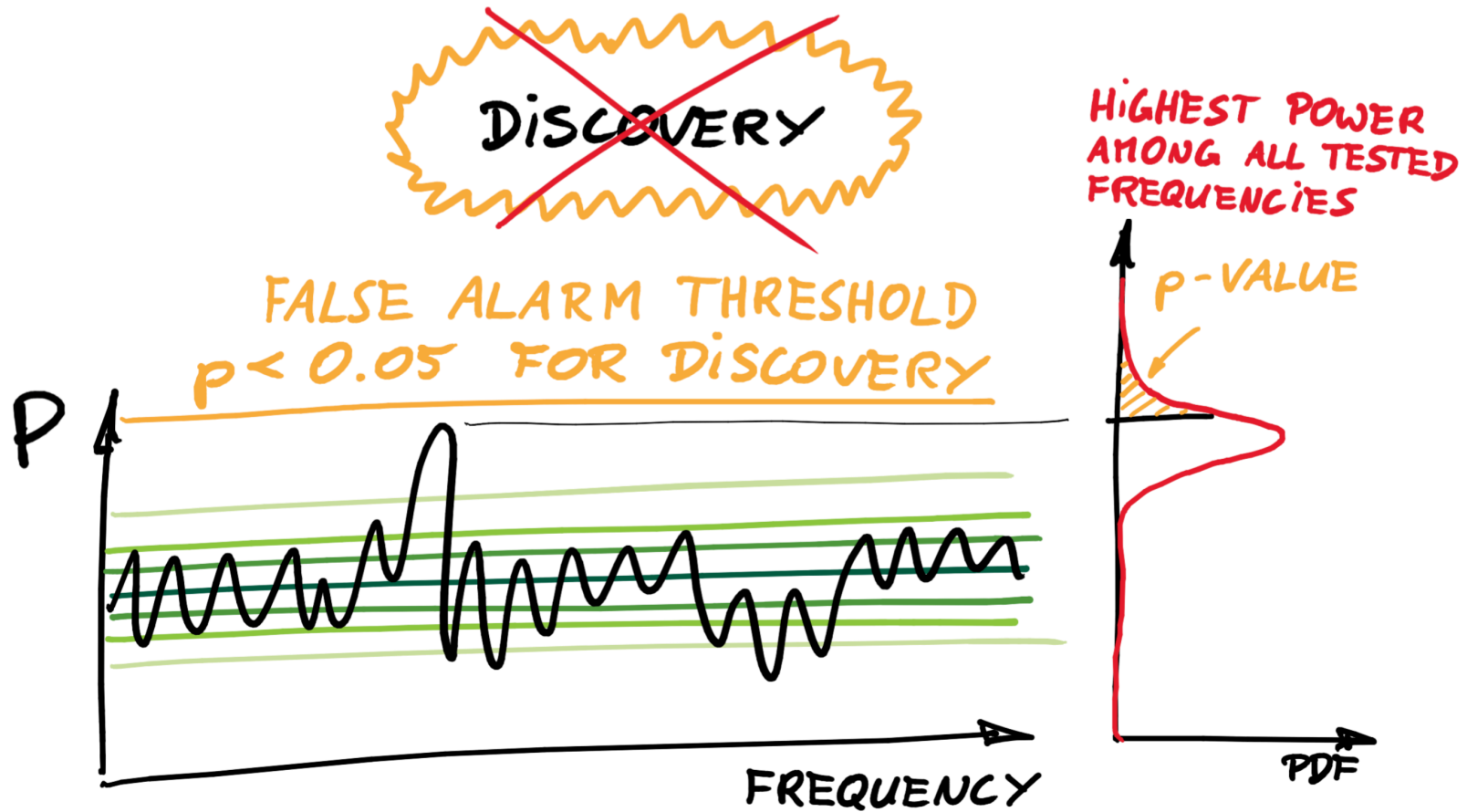
Y. V. Stadnik, V. V. Flambaum, Phys. Rev. D **89**, 043522 (2014)

J. D. Scargle, Astrophys. J. **263**, 835 (1982)

S. Algeri, J. Conrad, D. A. van Dyk, B. Anderson, arXiv:1602.03765 (2016)

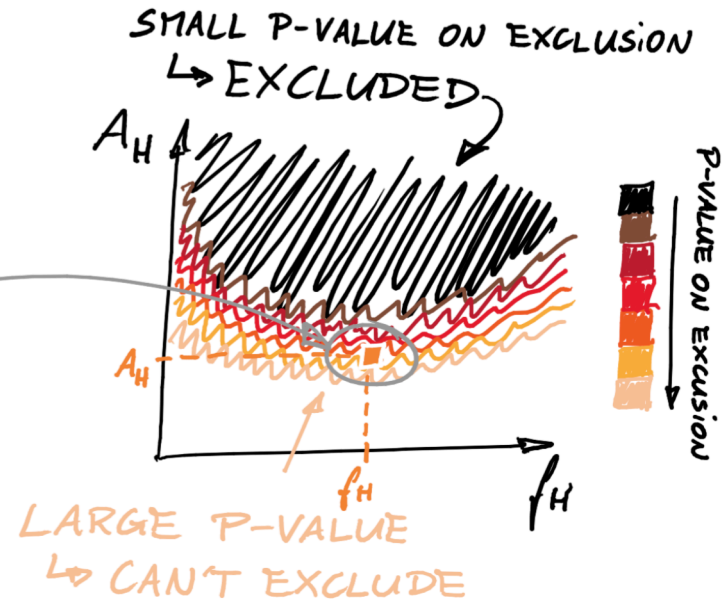
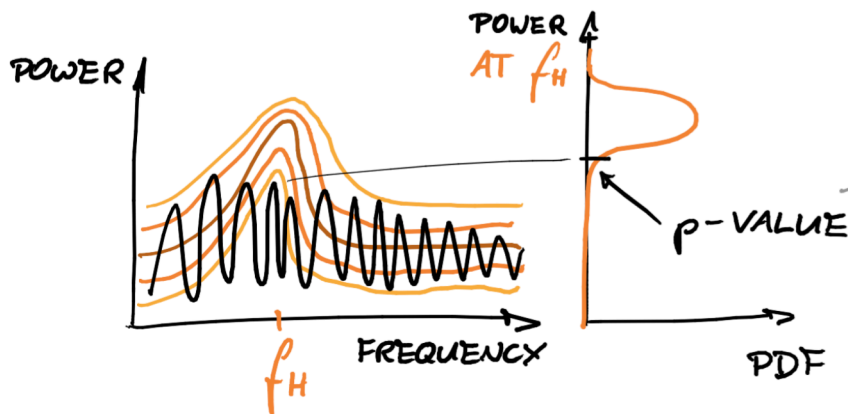
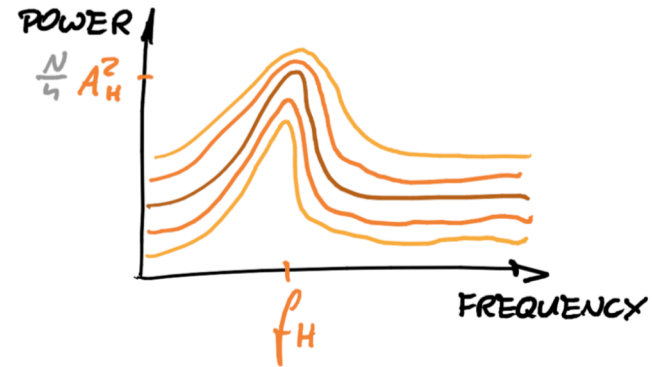
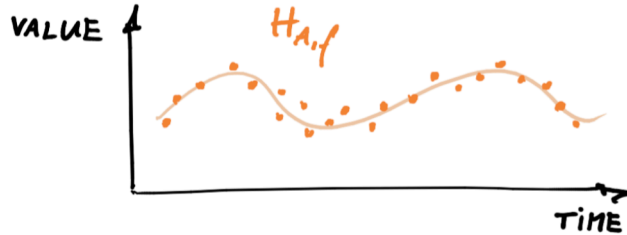


the look-elsewhere effect





determining the exclusion region



the exclusion region

