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Quasi-periodic sub-pulse structure as a unifying feature for radio-emitting neutron stars

Michael Kramer, Kuo Liu, Gregory Desvignes, Ramesh Karuppusamy & Ben W. Stappers

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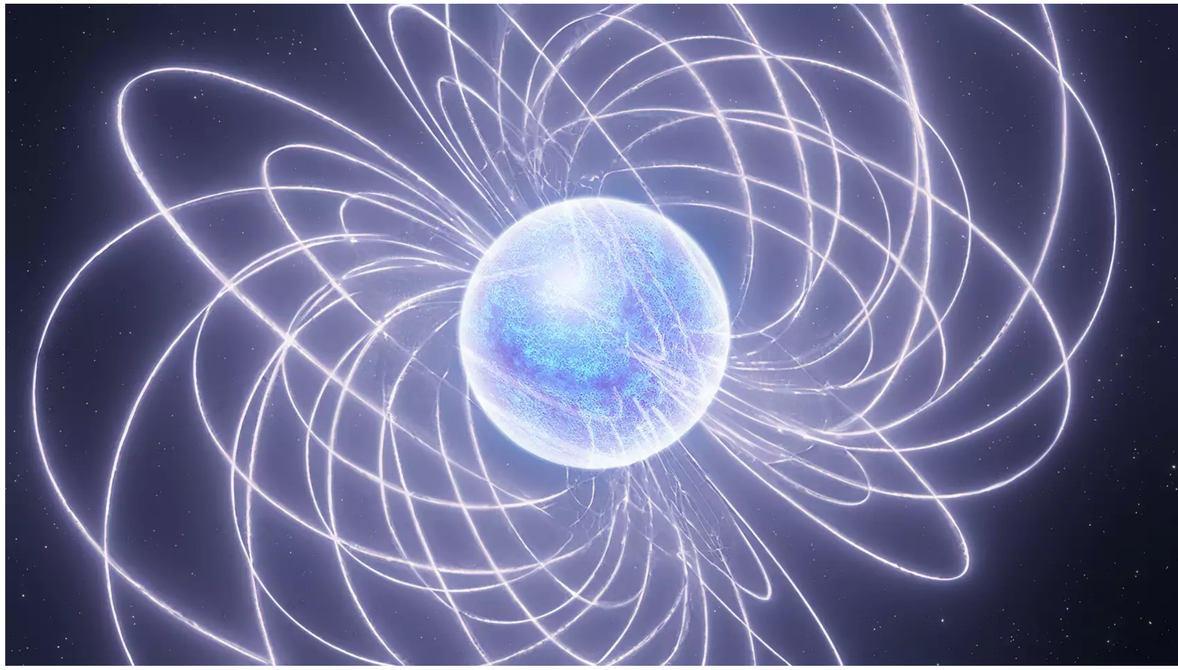
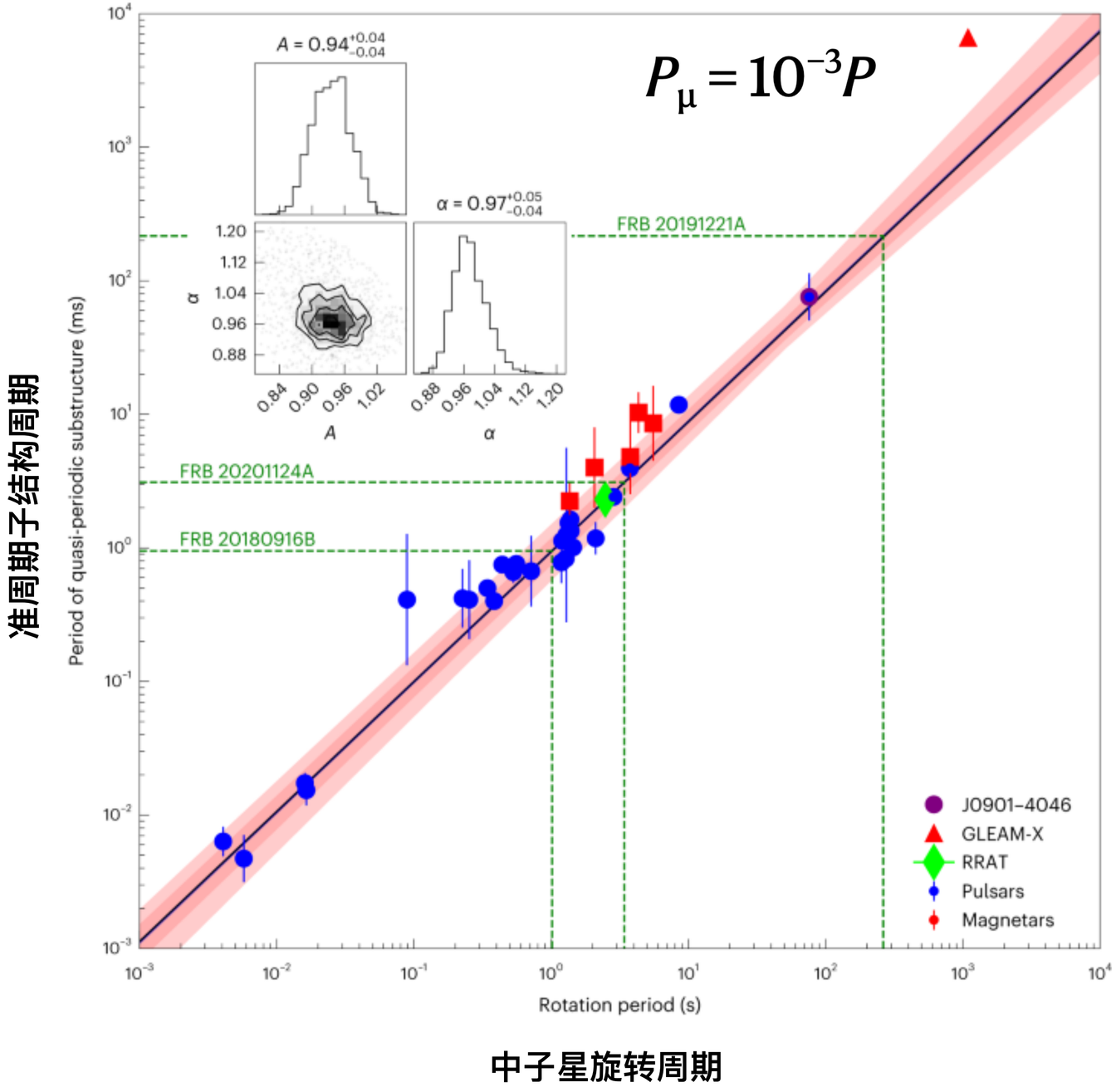


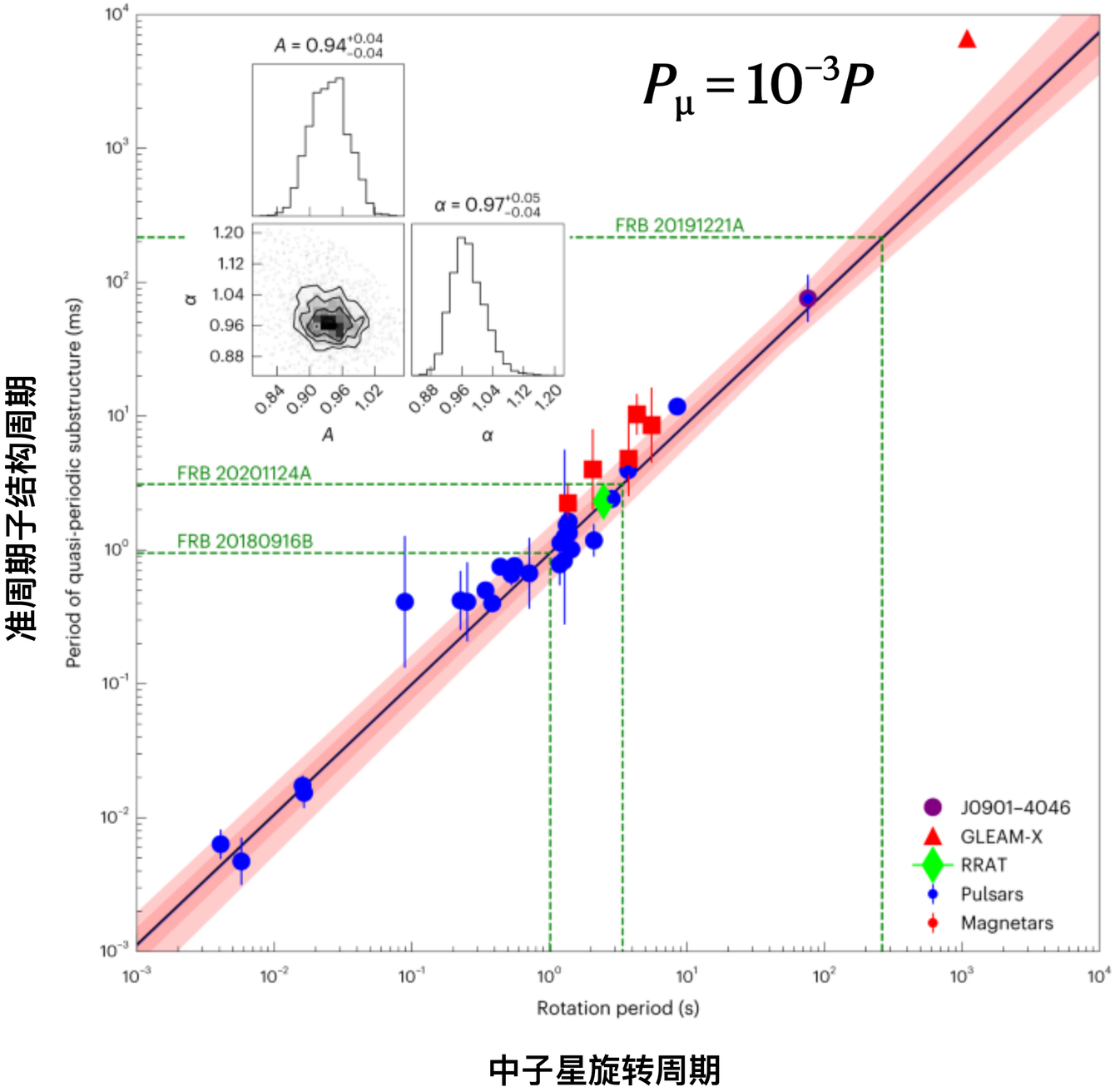
射电脉冲的准周期子结构：各类中子星的统一特征

Presented by Xun Shi 石洵 at faculty journal club, SWIFAR 2024.03



准周期子结构周期

中子星旋转周期

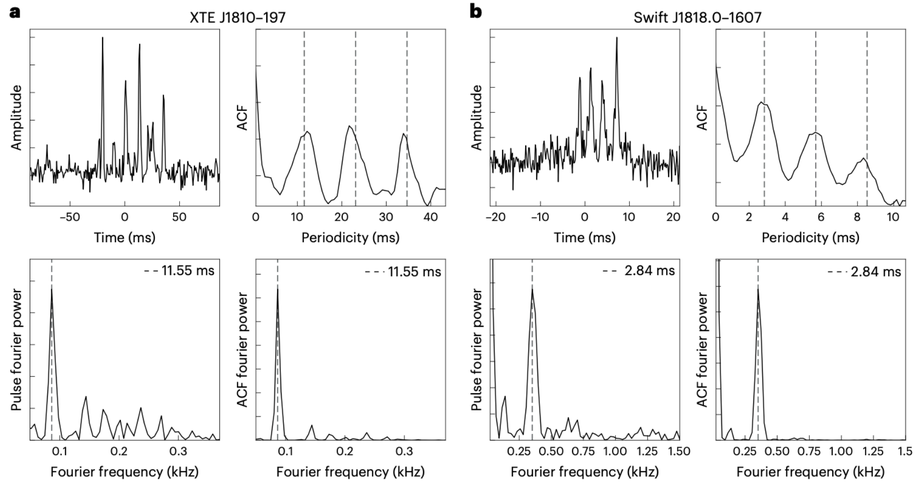


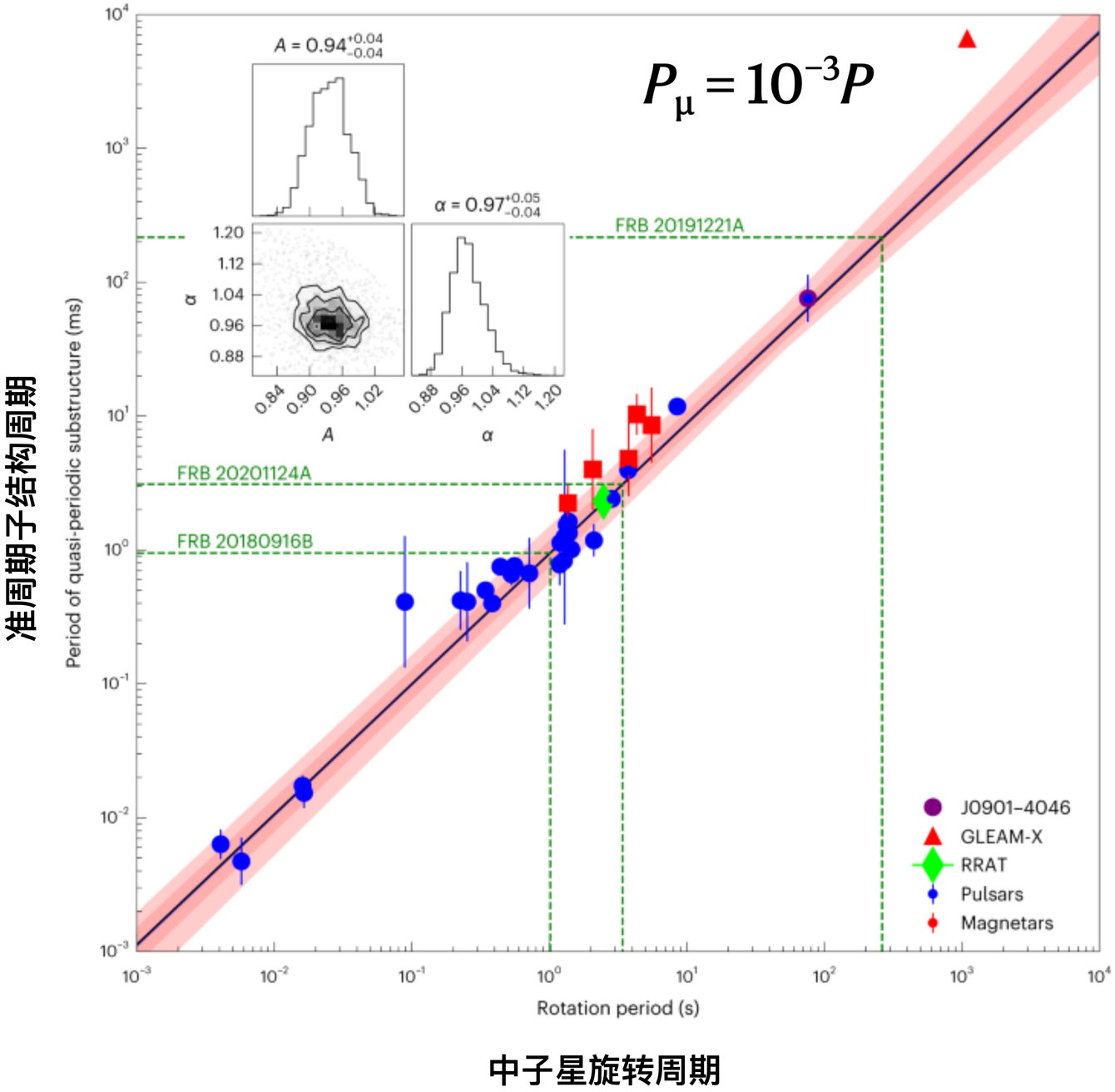
准周期子结构周期

中子星旋转周期

- **What are the “quasi-periodic substructures”**

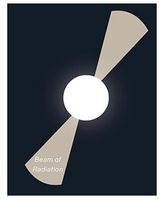
Examples of quasi-periodic substructure from magnetars



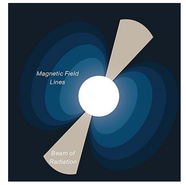


- **What are the data points?**

Pulsars



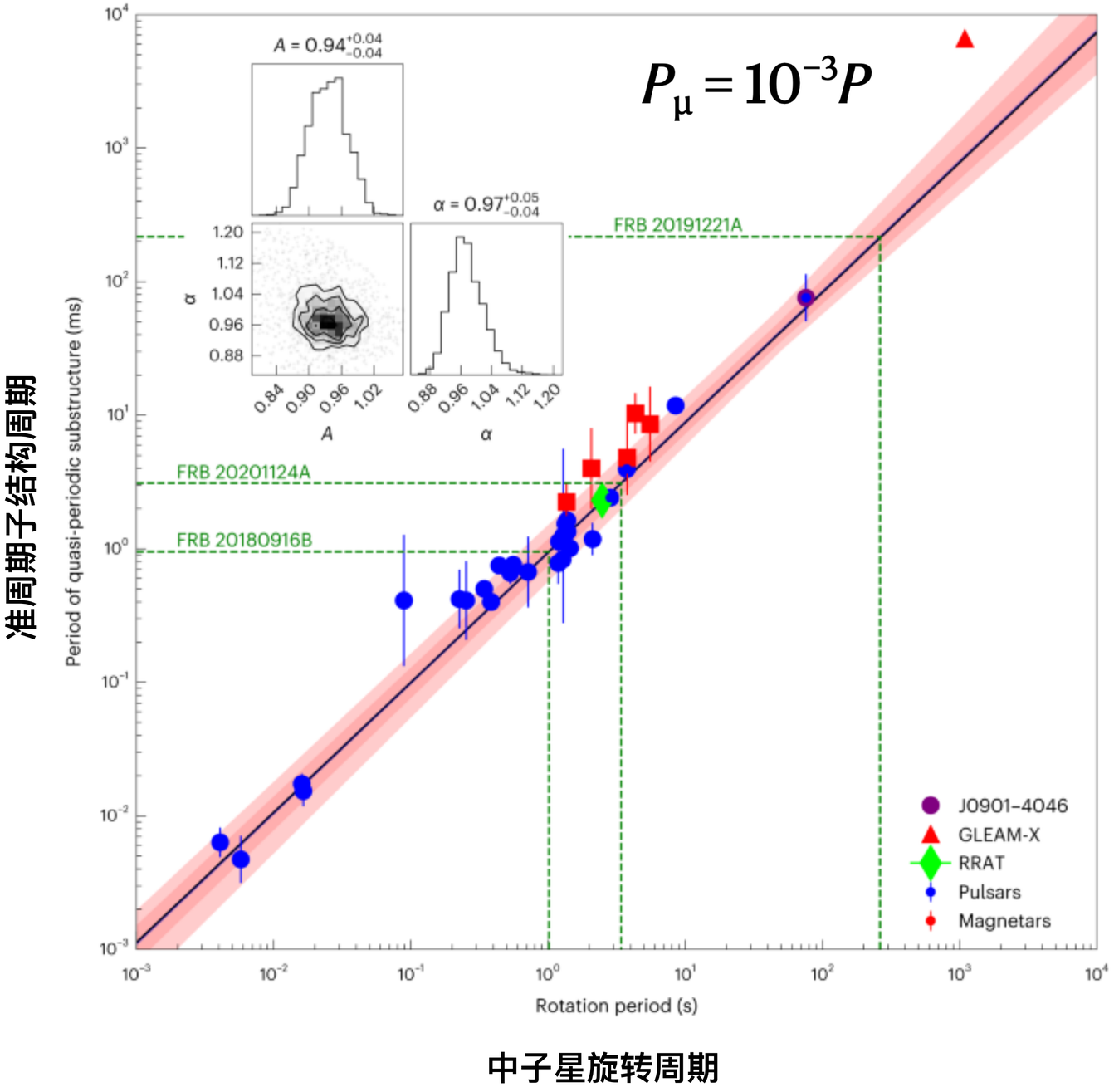
Magnetars **(+ pulsar)**



RRAT — **Rotating radio transients** sourced by subset of rotating neutron stars that emit radio pulses sporadically

J0901–4046 — P=**76s pulsar**

GLEAM-X — **ultra-long-period old magnetar with P=1090s**

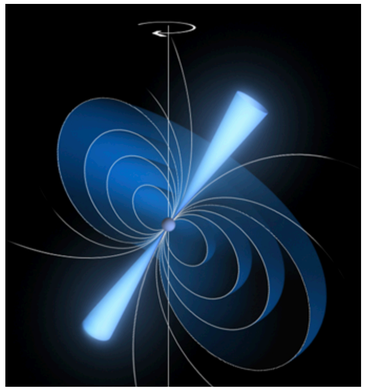


- **What's the significance of this relation?**

A relation across many orders of magnitudes (>5)

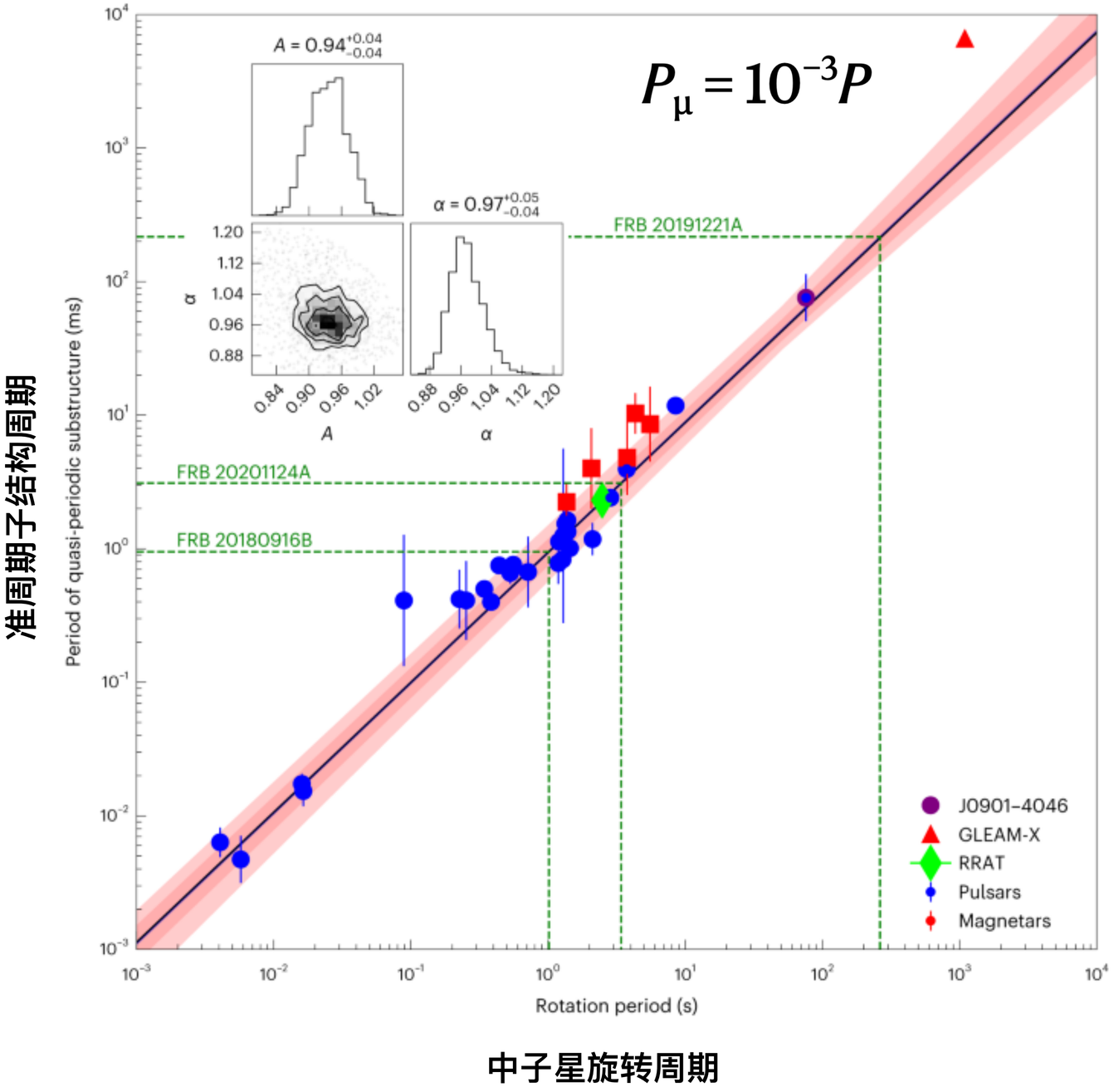
Intrinsic origin of the subpulse structure must be the same for all radio-loud neutron stars

Reveals information about the plasma process responsible for the radio emission



Pulsar radio emission mechanism: still no consensus

Is this correlation expected?



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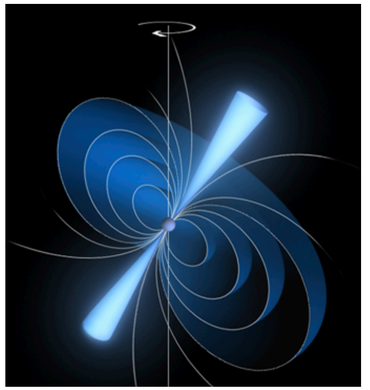
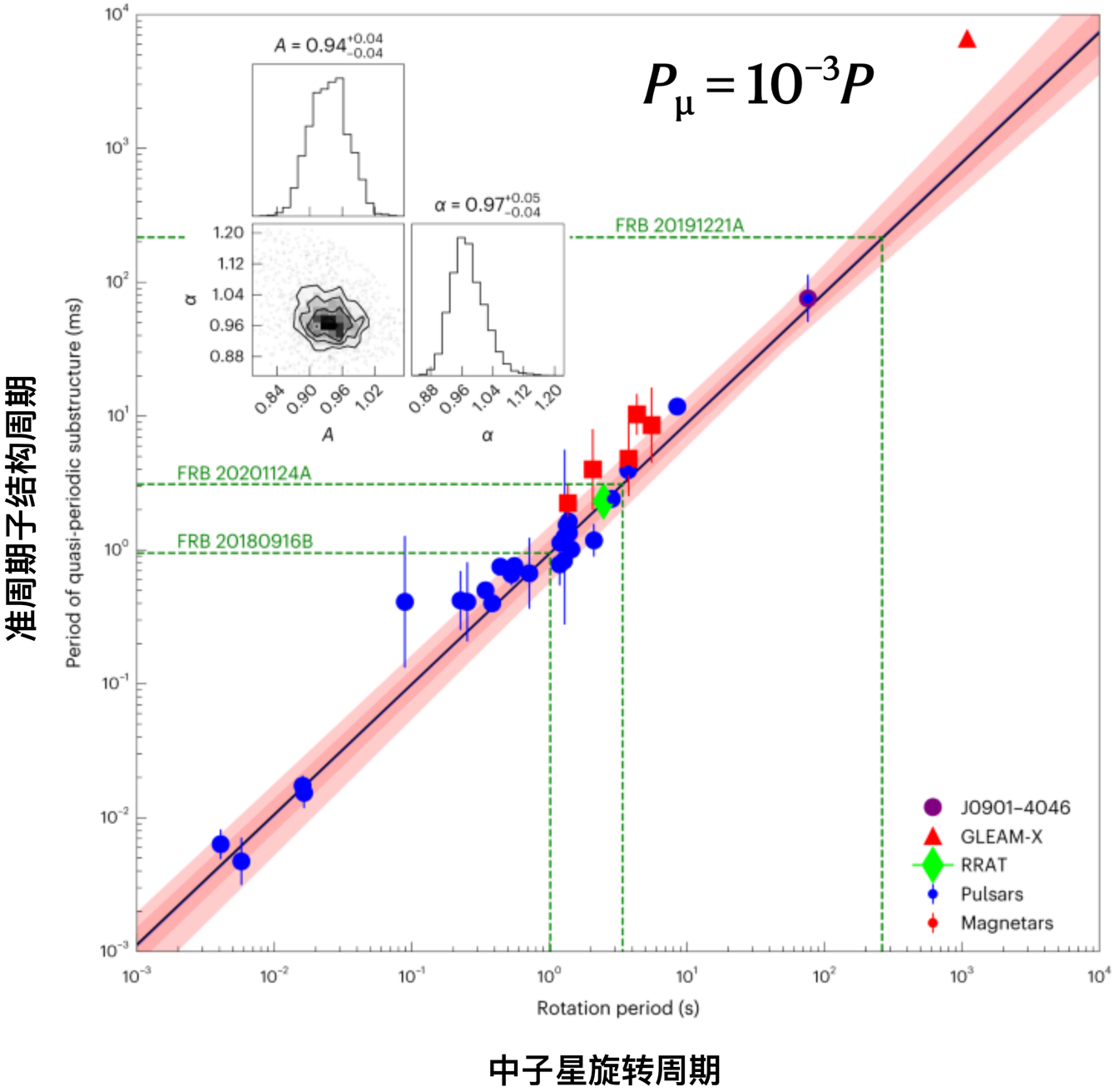


Pulsar radio emission mechanism: still no consensus

Is this correlation expected? Not really. Magnetars powered by magnetic field energy, others powered by rotational energy; Some are very old, some are very young.



- **Possible application of this relation?**

Infer underlying rotational periods from FRBs?

Because:

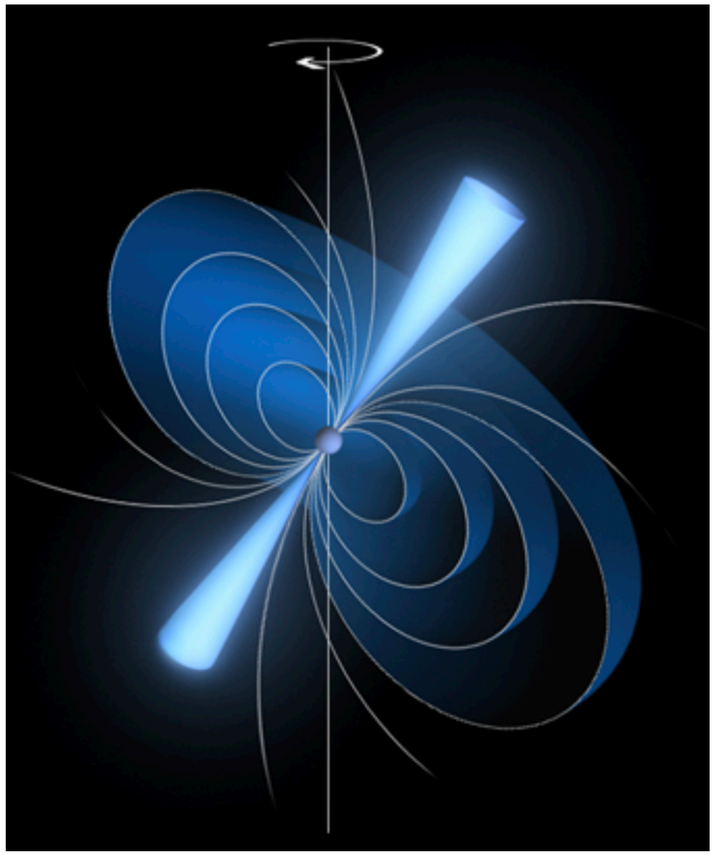
FRBs can be magnetars (energetic; example of SGR J1935+2154);

Although periodicity has not been discovered for FRBs, quasi-periodic substructures are

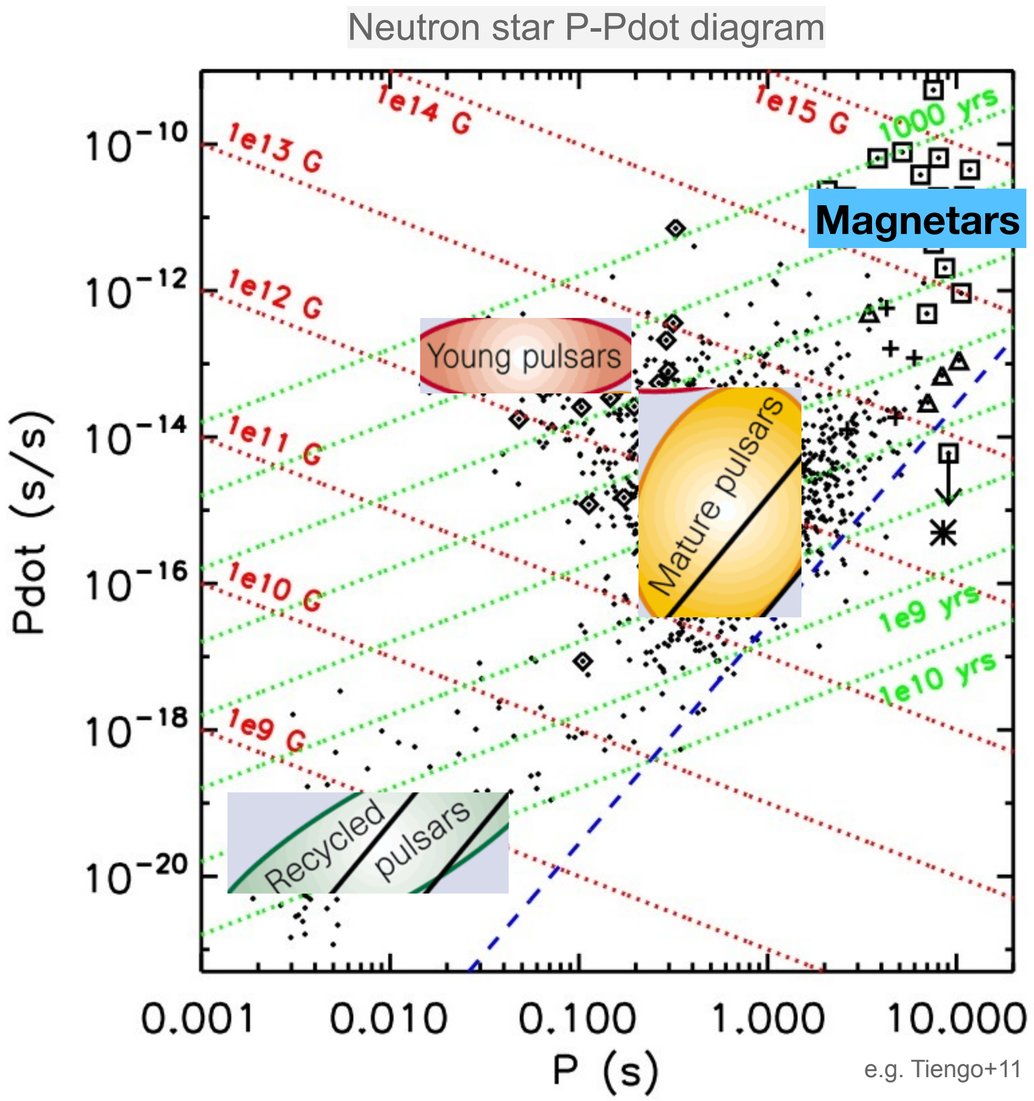
Pulsar radio emission mechanism: still no consensus

Relativistic charged particles
+ Magnetic fields

But in detail:
coherent curvature emission (CCE) or
relativistic plasma emission (RPE) or
anomalous Doppler emission (ADE) or
linear acceleration emission (LAE) or
free-electron maser emission (FEM) or
… ???



Classes of Neutron Stars



e.g. Tiengo+11