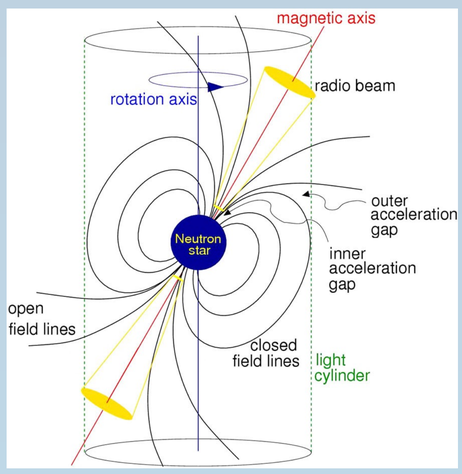
Correlations between Radio Emissions from Pulsars with Their X-ray Properties

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Introduction

Pulsars are fast-rotating, strongly magnetized neutron stars. Despite decades of study, the mechanisms responsible for their radiation remain unclear. This study presents correlations between radio emissions from X-ray-emitting pulsars and their X-ray properties. We found that the radio luminosity (L_ν) of pulsars is tightly correlated with their stellar surface temperature (kT). We also found that the group of pulsars with higher temperatures shows a different correlation from those with lower temperatures. The analysis of the radio emissions from pulsars may reveal differences between pulsars with varying X-ray emission properties and provide further insight into the emission mechanism of pulsars. The implication of our findings is being investigated.



(Lorimer and Kramer, 2005)

Emission From Pulsars

X-ray Emission – Incoherent Emission

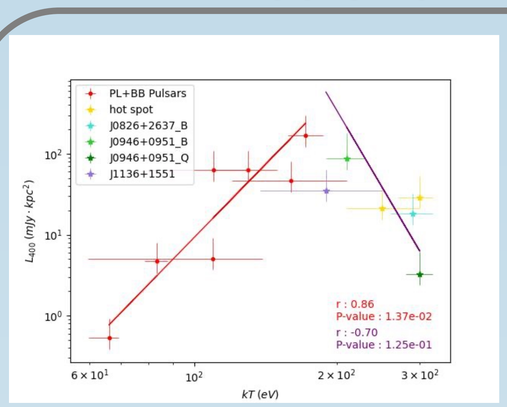
- Thermal emission
- Non-thermal emission

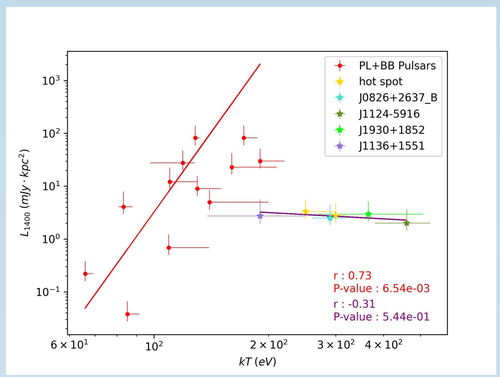
Radio Emission – Coherent Emission

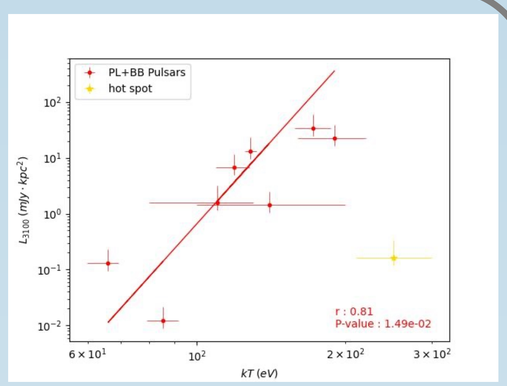
- Non-thermal emission
- Highly polarized
- High brightness temperature

Rotation-powered pulsars exhibit broad emission spanning from radio waves to gamma rays. In addition, both X-ray emission and radio emissions of pulsars share the same magnetospheric physics and spin-down power.

Radio Luminosity vs. Thermal X-ray Properties





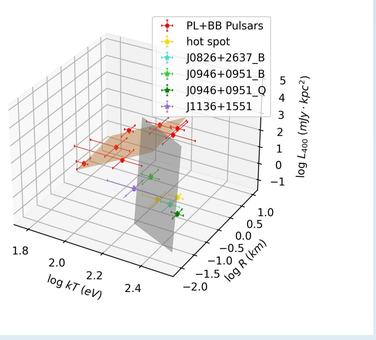


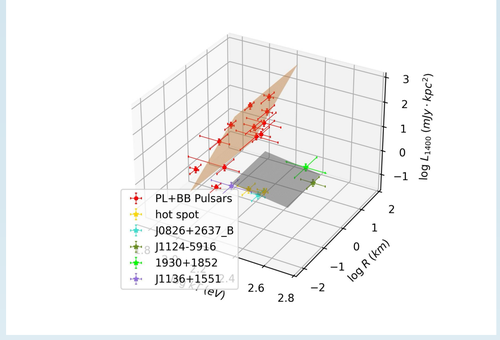
Radio luminosity at 400 MHz, 1400 MHz, 3100 MHz vs. stellar surface temperature

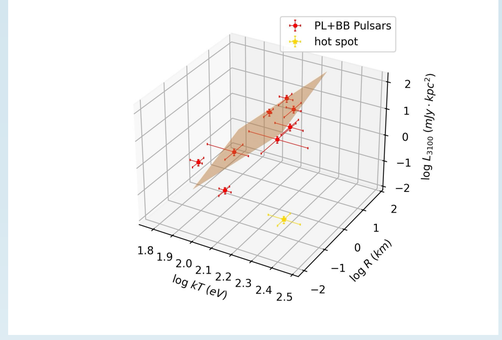
- From the correlation between L_ν and kT, pulsars with thermal emission are divided into the low-temperature group and the high-temperature group.

$L_{400} \propto kT^{5.99\pm0.65}$ $(\chi_\nu{}^2 = 0.709)$ $\quad L_{400} \propto kT^{-9.90\pm4.62}$ $(\chi_\nu{}^2 = 1.163)$
$L_{1400} \propto kT^{10.06\pm2.24}$ $(\chi_\nu{}^2 = 4.323)$ $\quad L_{1400} \propto kT^{-0.39\pm0.24}$ $(\chi_\nu{}^2 = 0.123)$
$L_{3100} \propto kT^{9.79\pm2.39}$ $(\chi_\nu{}^2 = 5.421)$

- Pulsars in the low-temperature group show a tentative positive correlation between L_ν and kT, but pulsars in the high-temperature group do not.







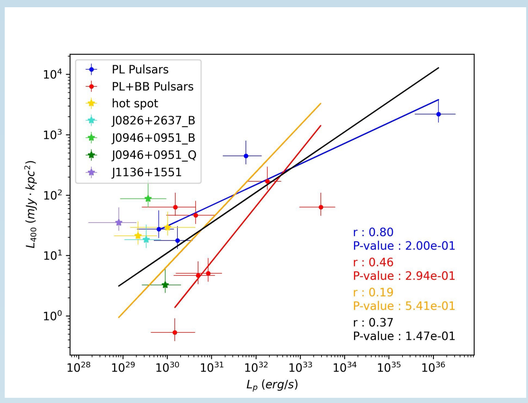
Radio luminosity at 400 MHz, 1400 MHz, 3100 MHz vs. stellar surface temperature and thermal emitting radius

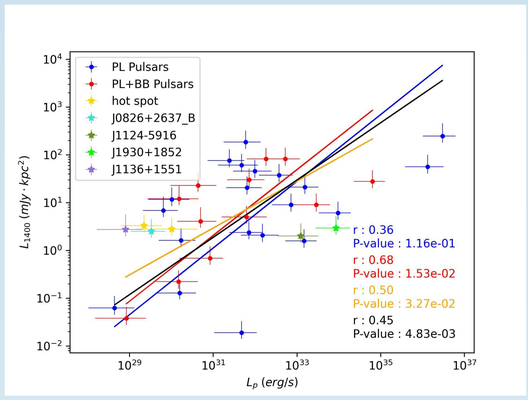
- The relation of L_ν and thermal X-ray properties of pulsars in the low-temperature group:

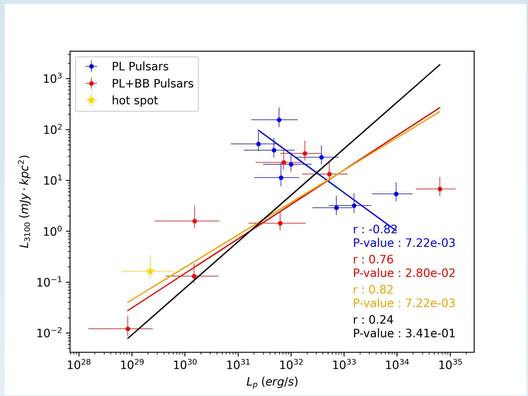
$L_{400} \propto kT^{5.79\pm0.79} R^{0.23\pm0.26}$ $(\chi_\nu{}^2 = 0.668)$
$L_{1400} \propto kT^{6.25\pm1.44} R^{0.72\pm0.36}$ $(\chi_\nu{}^2 = 3.929)$
$L_{3100} \propto kT^{6.83\pm1.85} R^{0.38\pm0.43}$ $(\chi_\nu{}^2 = 7.024)$

- The correlation between L_ν, kT, and R of pulsars in the group of lower temperature suggests the existence of a fundamental plane.

Radio Luminosity vs. Non-thermal X-ray Properties







Radio luminosity at 400 MHz, 1400 MHz, 3100 MHz vs. non-thermal X-ray luminosity