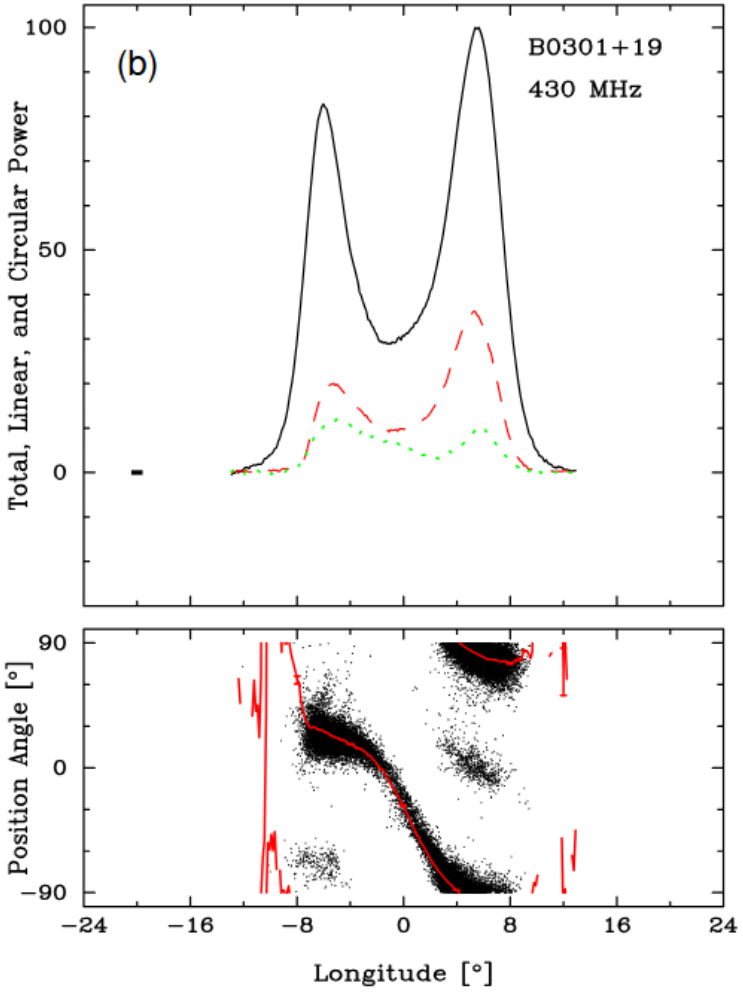
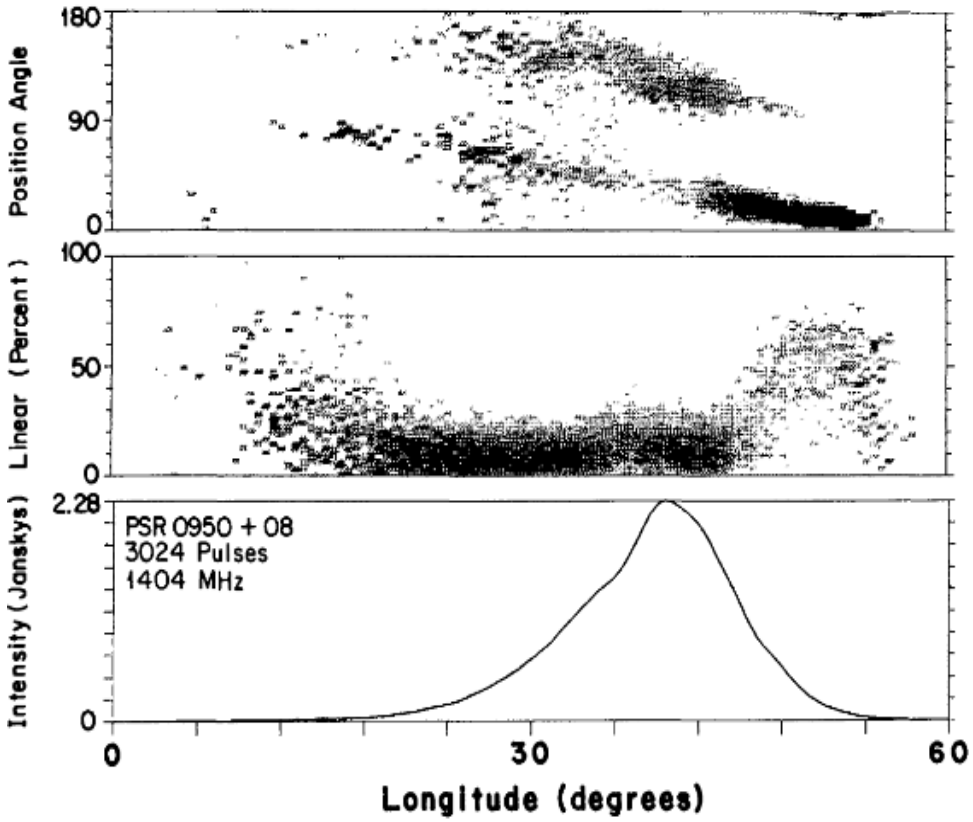
К статистике радиопульсаров по новым поляризационным данным FAST и MeerKAT

Ф. А. Князев, А. Ю. Истомин, В. С. Бескин

Ортогональные моды





T.Hankins, J.Rankin,
AJ, **139**, 168 (2010)

Taylor and Stinebring
ARA&A, 24:285–327 (1986)

Моды излучения

V.S.Beskin A.V.Gurevich, Ya.N.Istomin. ApSS, **146,** 205 (1988)

$$\varepsilon_{ij} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 - < \frac{\omega_p^2}{\varpi^2 \gamma^3} > \end{pmatrix}$$

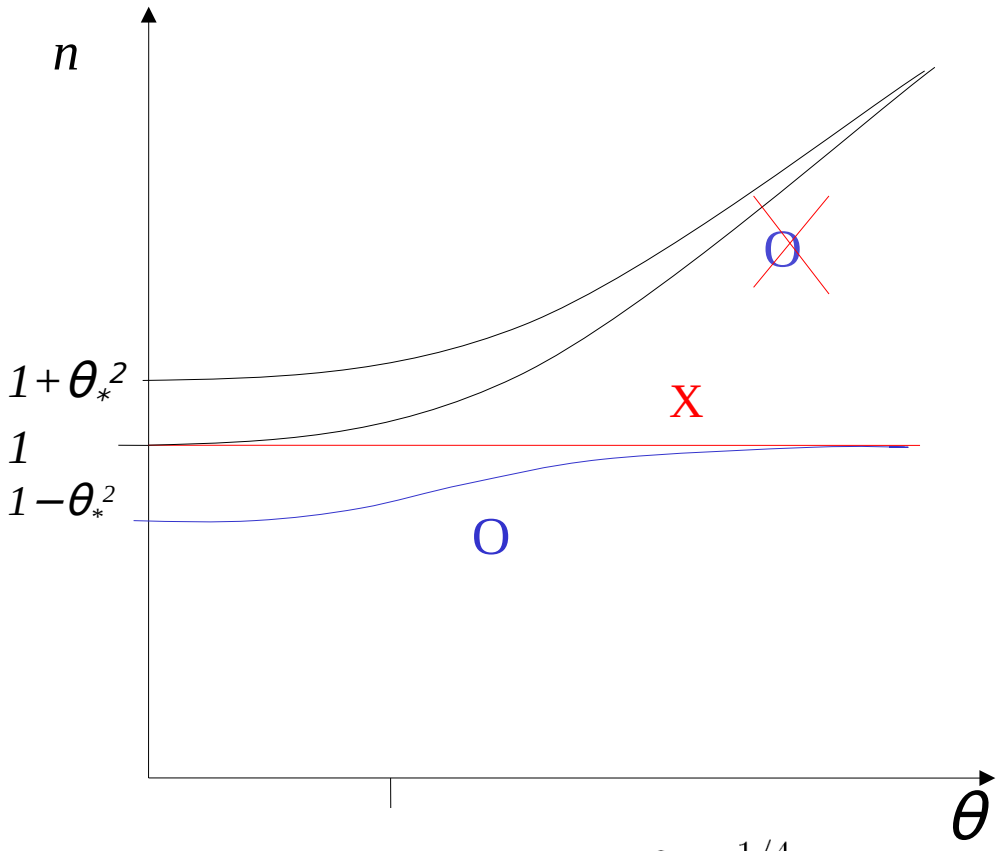
If $$A_{\rm p} = \frac{\omega_p^2}{\omega^2} < \gamma > \gg 1$$

$$n_1 = 1,$$

$$n_2 = 1 + \frac{\theta^2}{4} - \left(\frac{\omega_p^2}{\omega^2} < \frac{1}{\gamma^3} > + \frac{\theta^4}{16} \right)^{1/2},$$

$$n_3 = 1 + \frac{\theta^2}{4} + \left(\frac{\omega_p^2}{\omega^2} < \frac{1}{\gamma^3} > + \frac{\theta^4}{16} \right)^{1/2},$$

$$n_4 = \frac{1}{\cos\theta}.$$



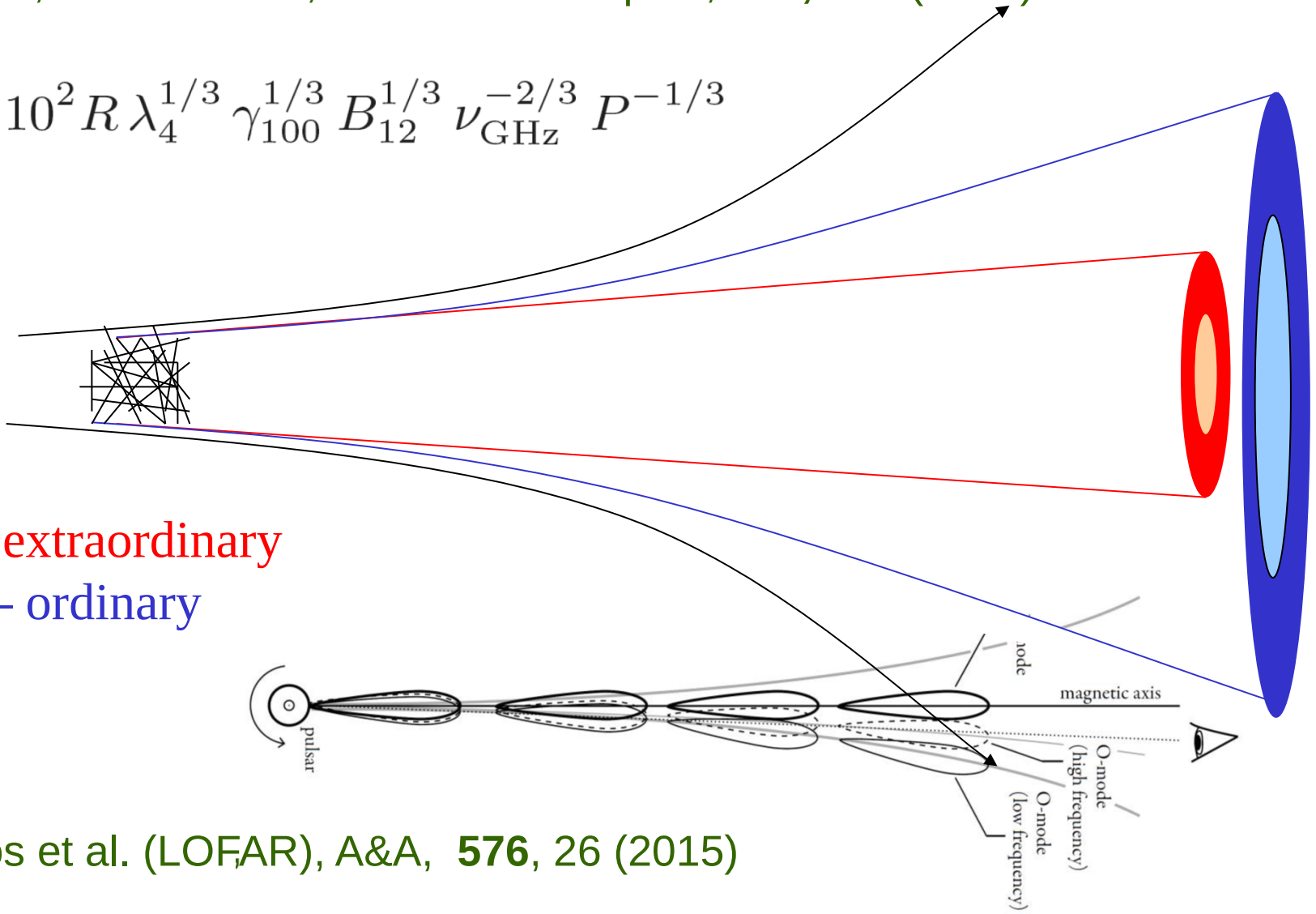
$$\theta_* = < \left(\frac{\omega_p^2}{\omega^2 \gamma^3} \right)^{1/4} >$$

A.Lyne, F.Graham-Smith.
Pulsar Astronomy, 3rd edition

Core & Conal

V.S.Beskin, A.V.Gurevich, Ya.N.Istomin. ApSS, **146,** 205 (1988)

$$r_{\rm A} \approx 10^2 R\, \lambda_4^{1/3}\, \gamma_{100}^{1/3}\, B_{12}^{1/3}\, \nu_{\rm GHz}^{-2/3}\, P^{-1/3}$$



A.Noutsos et al. (LOFAR), A&A, **576**, 26 (2015)

Предсказание

V.S.Beskin, A.V.Gurevich, Ya.N.Istomin, ApSS, **146,** 205 (1988)

$$W^{(1)}_{X} \approx 3.6^\circ \left(\frac{P}{1\,s}\right)^{-0.5} \left(\frac{\nu}{1\mathrm{GHz}}\right)^{-1/2} \left(\frac{\lambda}{10^4}\right)^{1/8} \left(\frac{B}{10^{12}\mathrm{G}}\right)^{1/8} \left(\frac{\gamma}{100}\right)^{7/8},$$

$$W^{(2)}_{O} \approx 7.8^\circ \left(\frac{P}{1\,s}\right)^{-0.43} \left(\frac{\nu}{1\mathrm{GHz}}\right)^{-0.14} \left(\frac{\lambda}{10^4}\right)^{0.07} \left(\frac{B}{10^{12}G}\right)^{0.07} \left(\frac{\gamma}{100}\right)^{-0.11},$$

$$W^{(2)} \approx 10^\circ \left(\frac{P}{1\,s}\right)^{-0.5} \left(\frac{\nu}{1\mathrm{GHz}}\right)^{-0.29} \left(\frac{\lambda}{10^4}\right)^{0.1} \left(\frac{B}{10^{12}\mathrm{G}}\right)^{0.1} \left(\frac{\gamma}{100}\right)^{-0.05}.$$

Но как определить моду?

А.С.Андрианов, В.С.Бескин, ПАЖ, **36**, 260 (2010)
V.S.Beskin, A.A.Philippov, MNRAS, **425**, 814 (2012)
H.L.Hakobyan, V.S.Beskin, A Philippov, MNRAS, **469**, 2704 (2017)

$$\frac{\mathrm{d}\theta_1}{\mathrm{d}r} = -\frac{1}{2}\frac{\omega}{c}\frac{\Delta n}{\sqrt{q^2+1}} - \frac{1}{2}\frac{\omega}{c}\cos[2\theta_1 - 2\beta(r)]\frac{\Delta nq}{\sqrt{q^2+1}}\mathrm{sh}2\theta_2,$$

$$\frac{\mathrm{d}\theta_2}{\mathrm{d}r} = \frac{1}{2}\frac{\omega}{c}\frac{\Delta nq}{\sqrt{q^2+1}}\sin[2\theta_1 - 2\beta(r)]\mathrm{ch}2\theta_2.$$

O-мода (conal): знаки d*p.a.*/dphi и V противоположны
X-мода (core): знаки d*p.a.*/dphi и V одинаковы

O-мода шире (и в основном D)
X-мода уже (и в основном S)

FAST – 682

Research in Astronomy and Astrophysics, 23:104002 (105pp), 2023 October
https://doi.org/10.1088/1674-4527/acea1f

CrossMark

FAST Pulsar Database. I. Polarization Profiles of 682 Pulsars

P. F. Wang[1,2], J. L. Han[1,2], J. Xu[1,2], C. Wang[1,2], Y. Yan[1,2], W. C. Jing[1,2], W. Q. Su[1,2], D. J. Zhou[1,2], and T. Wang[1,2]
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MeerKAT – 1170

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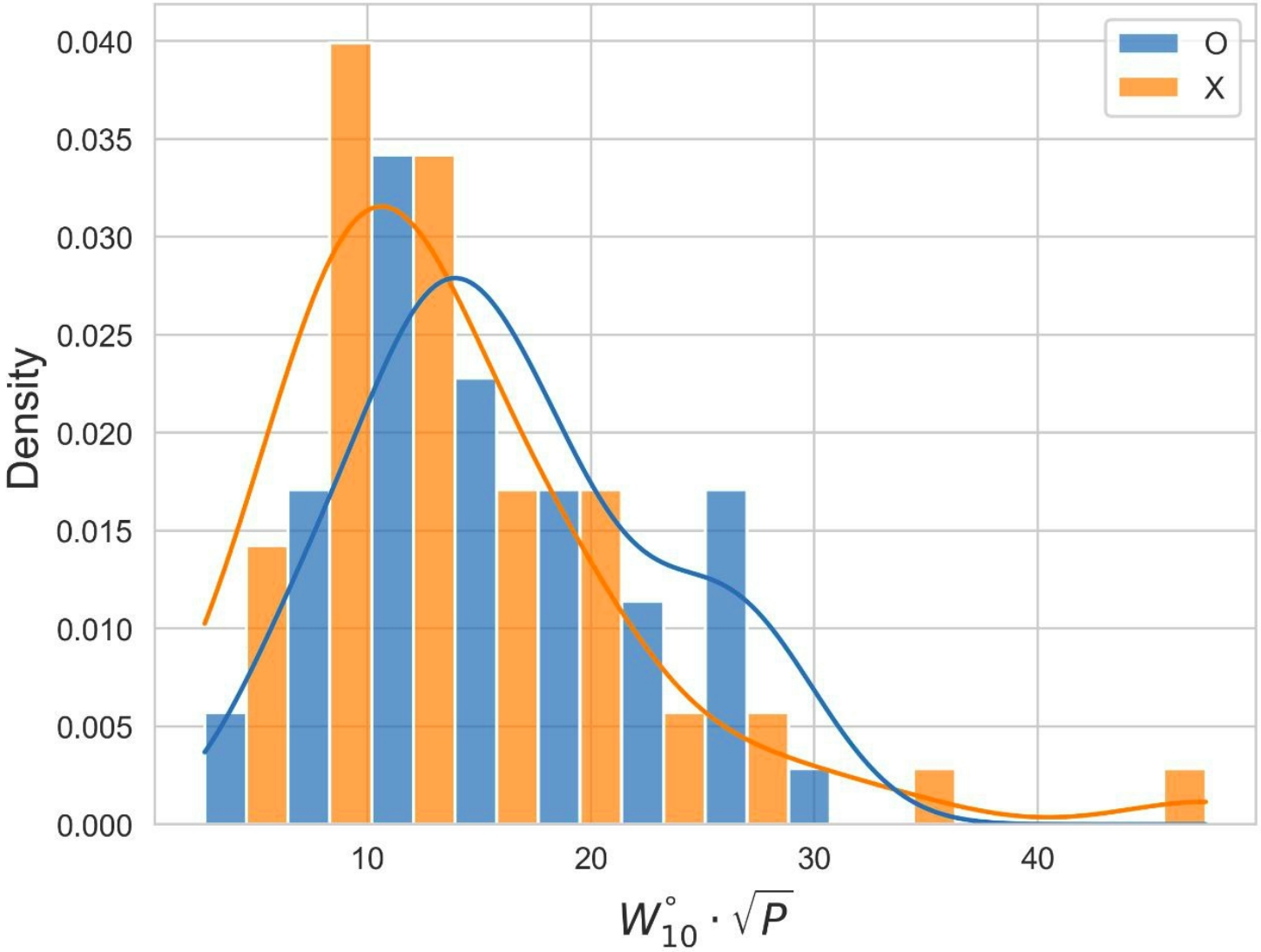
MNRAS **520,** 4582–4600 (2023) https://doi.org/10.1093/mnras/stac3383

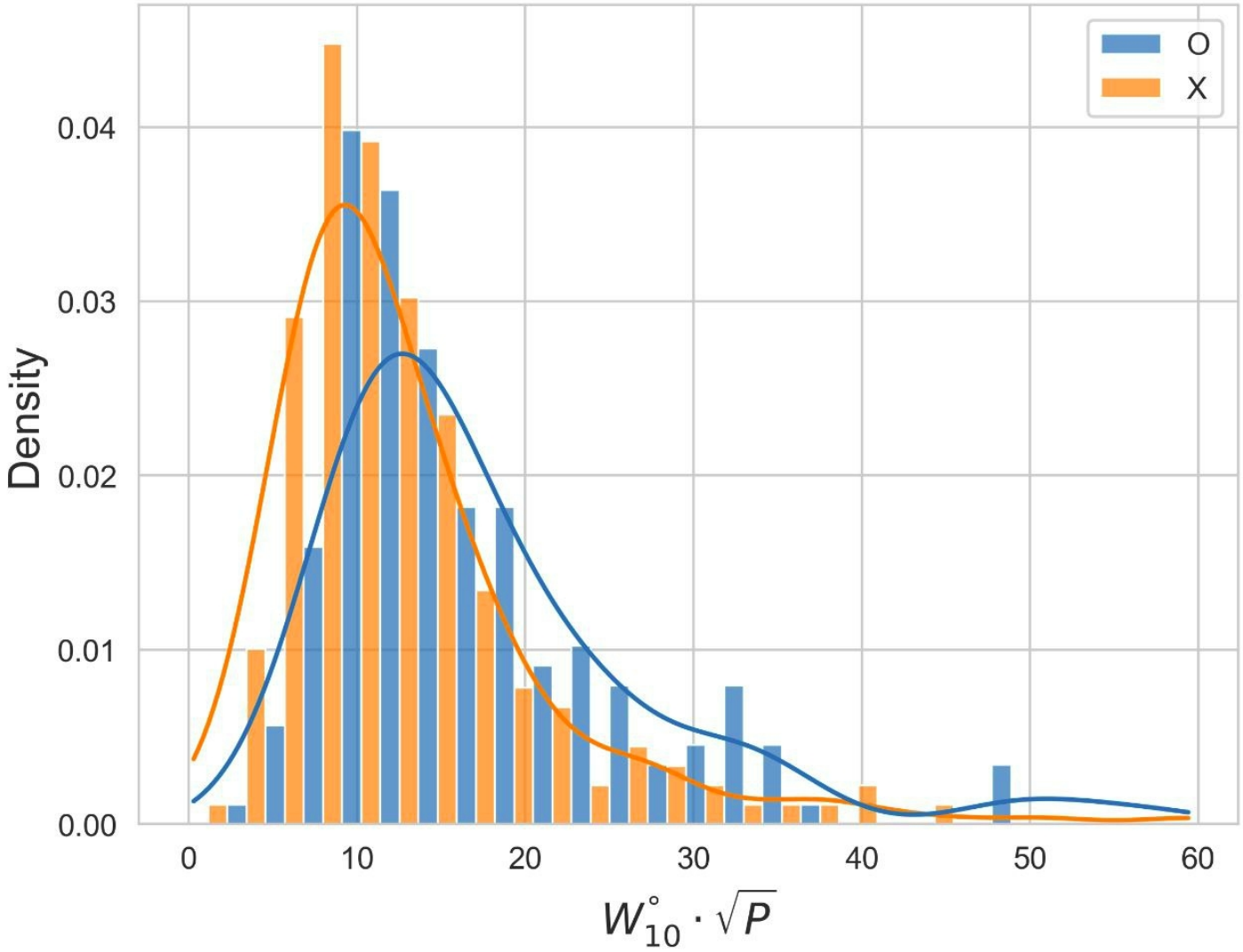
The Thousand Pulsar Array program on MeerKAT – IX. The time-averaged properties of the observed pulsar population

B. Posselt,[1,2★] A. Karastergiou,[1,3★] S. Johnston,[4] A. Parthasarathy,[5] L. S. Oswald,[1,6] R. A. Main,[5] A. Basu,[7] M. J. Keith,[7] X. Song,[7] P. Weltevrede,[7] C. Tiburzi,[8] M. Bailes,[9,10] S. Buchner,
M. Geyer,[11,12] M. Kramer,[5,7] P. Spiewak[7,9,10] and V. Venkatraman Krishnan[5]

Наблюдения FAST



Наблюдения MeerKat



Наблюдения

p-value	Способ определения моды			
	Вручную		Автоматический	
Статистический тест	FAST	MeerKAT	FAST	MeerKAT
Тест Андерсона-Дарлинга	0.03	0.001	0.04	0.005
Пермутационный тест	0.02	0.0001	0.02	0.009

	N	Xs	Xd	Os	Od	X_{tot}	O_{tot}
FAST	39+19+19+37	$12.4^{+2.4}_{-2.6}$	$12.7^{+5.7}_{-3.3}$	$12.6^{+6.1}_{-1.5}$	$16.0^{+2.7}_{-2.3}$	$12.5^{+2.3}_{-2.2}$	$15.4^{+2.5}_{-2.2}$
MeerKAT	178+36+93+114	$10.2^{+1.4}_{-0.7}$	$11.6^{+2.9}_{-1.6}$	$12.9^{+1.9}_{-1.1}$	$16.8^{+2.0}_{-1.5}$	$10.6^{+1.1}_{-0.9}$	$15.3^{+0.8}_{-1.8}$

Из 682 профилей FAST найдены 114 профилей X и O,
из 1170 профилей MeerKAT найдены 421 профилей X и O.