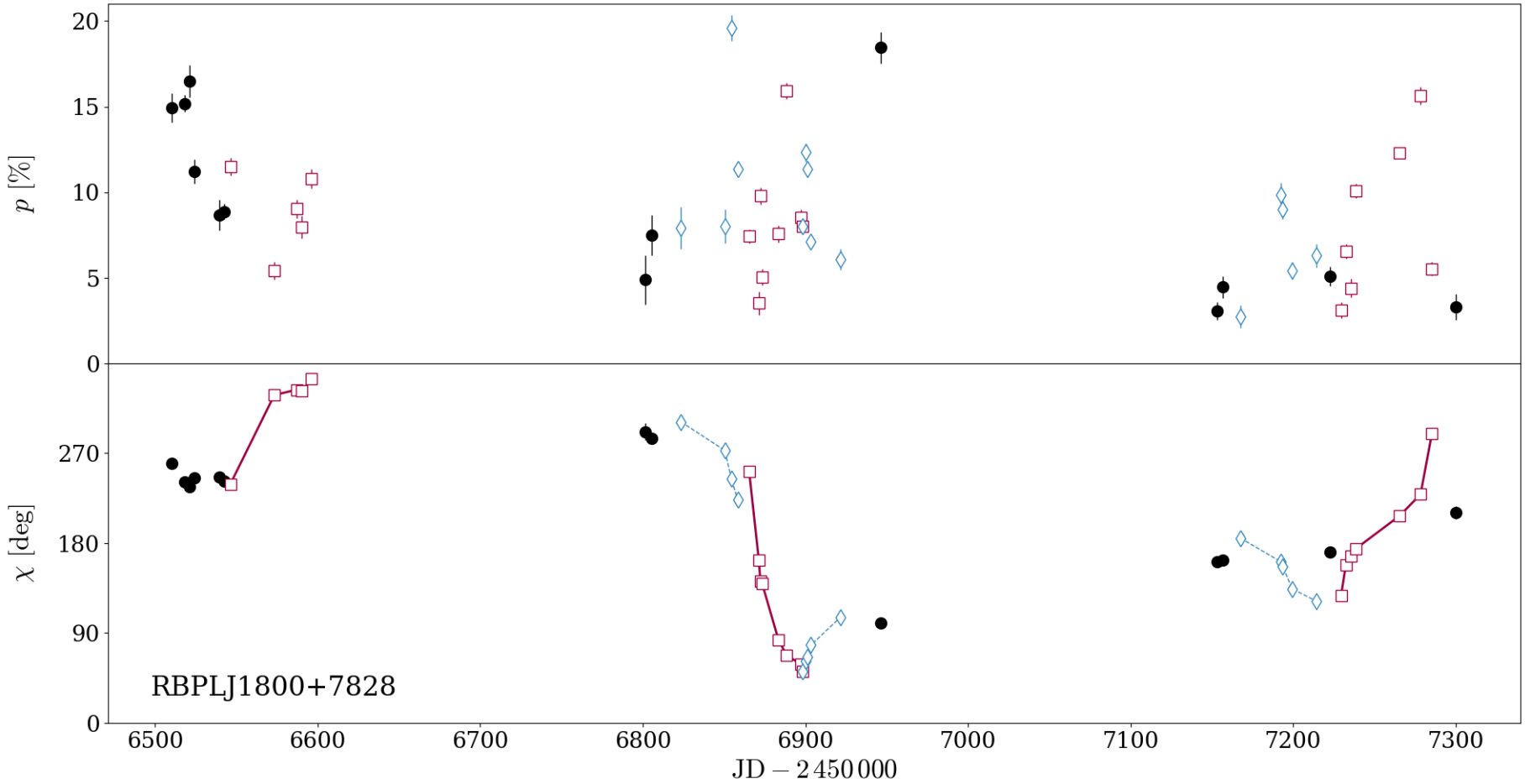
Testing a stochastic variability model of optical EVPA rotations in blazars with RoboPol data

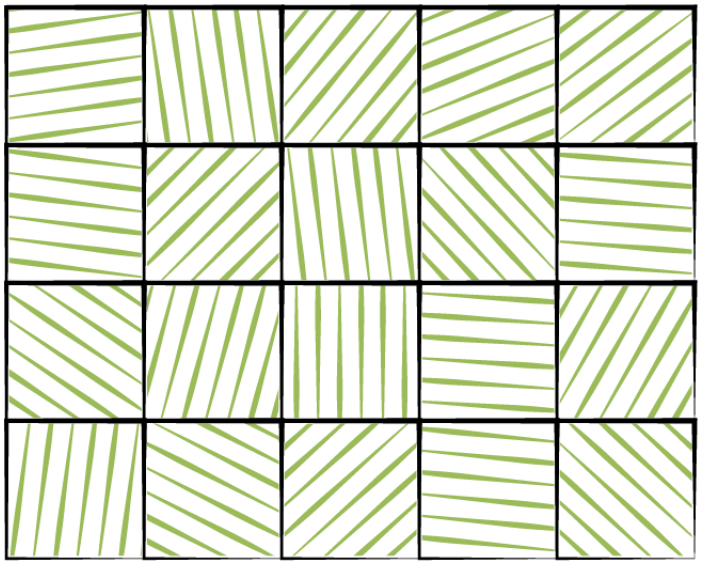
by Sebastian Kiehlmann
and the RoboPol collaboration

Caltech

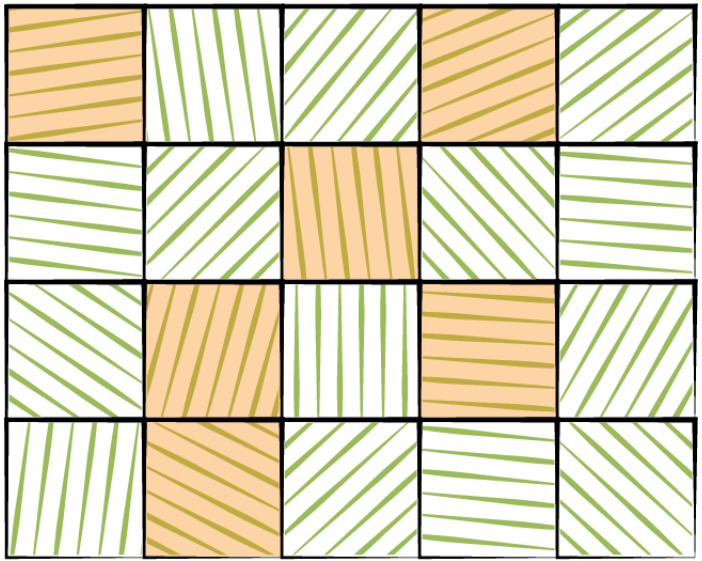
Aalto University


20
15
10
5
0
p [%]
270
180
90
0
χ [deg]
RBPLJ1800+7828
6500
6600
6700
6800
6900
7000
7100
7200
7300
JD − 2 450 000

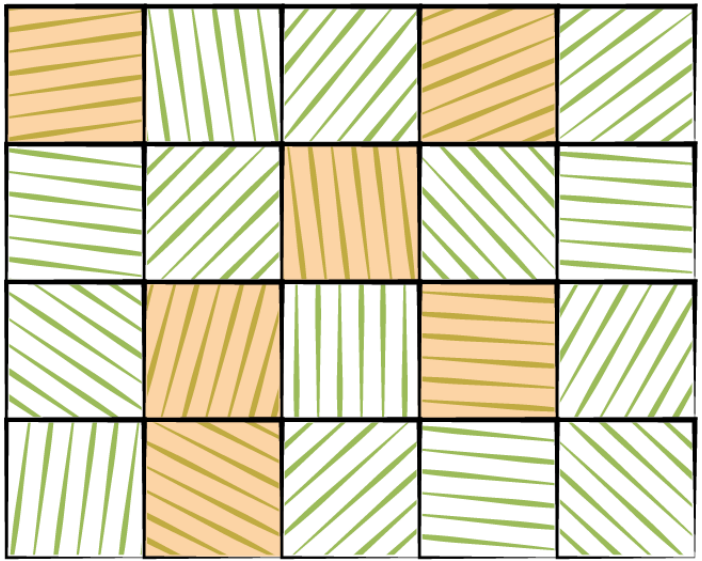
Model



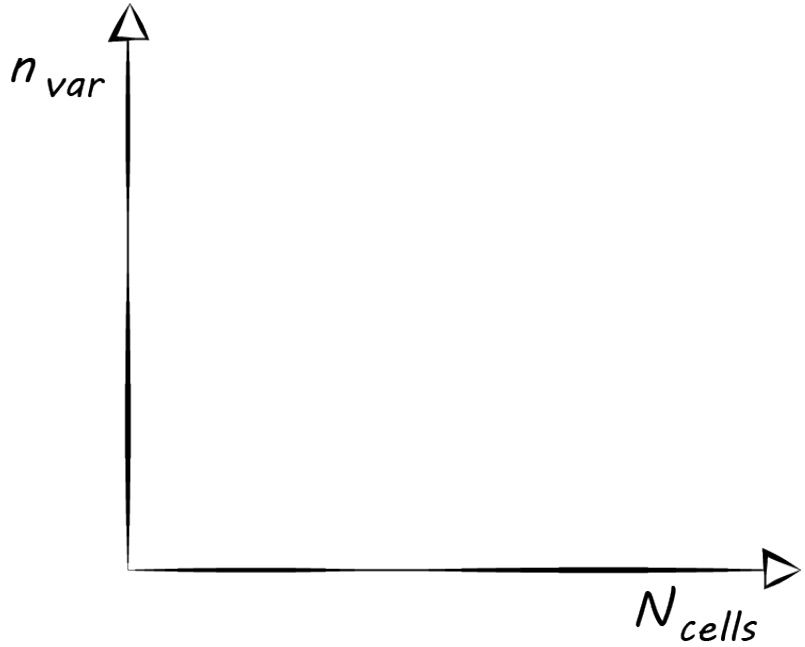
Model



Model

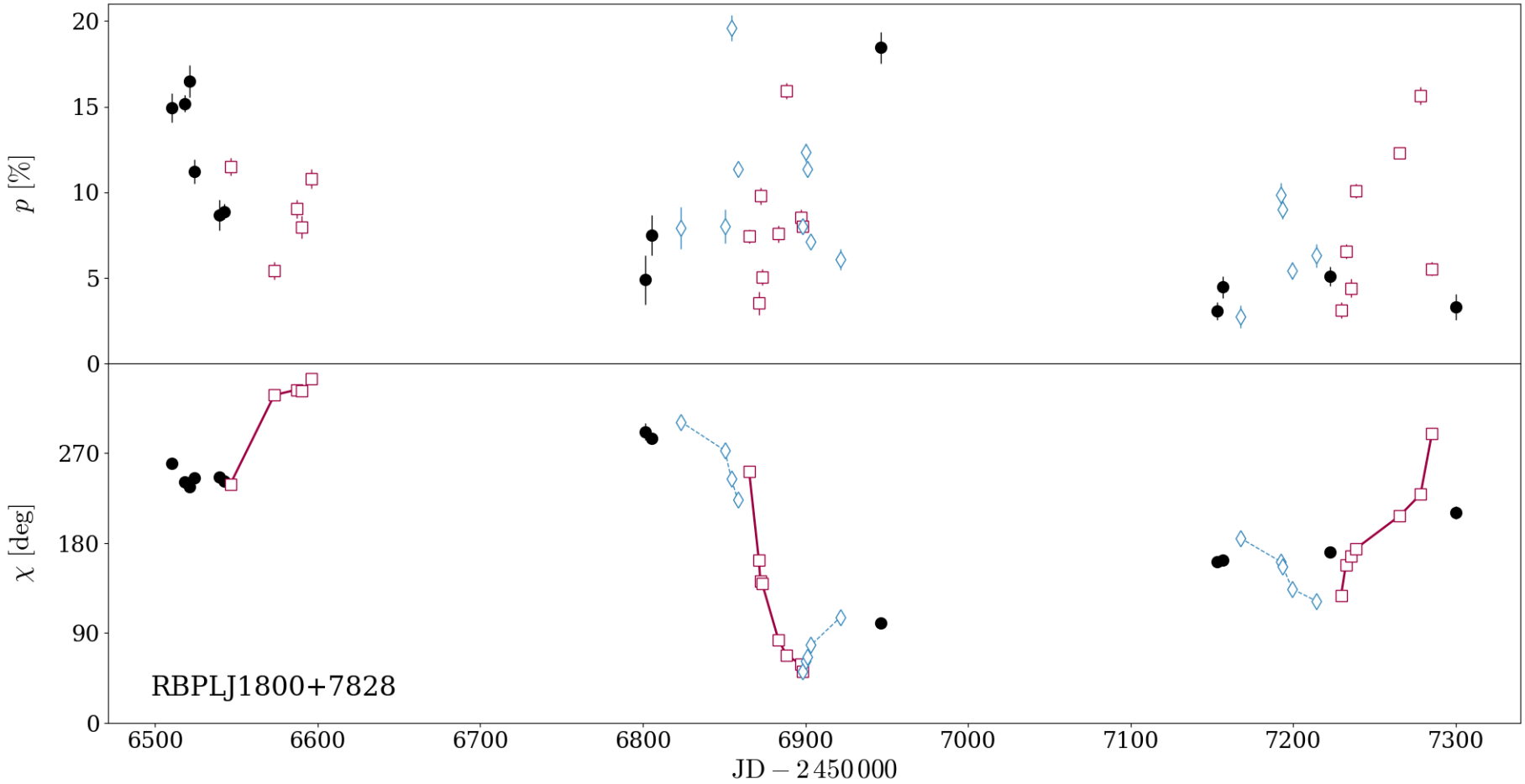


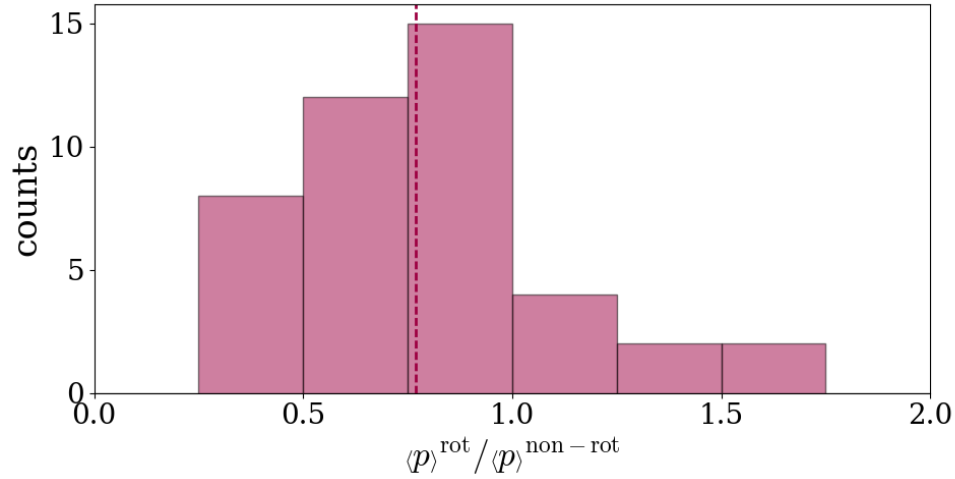
Parameter space

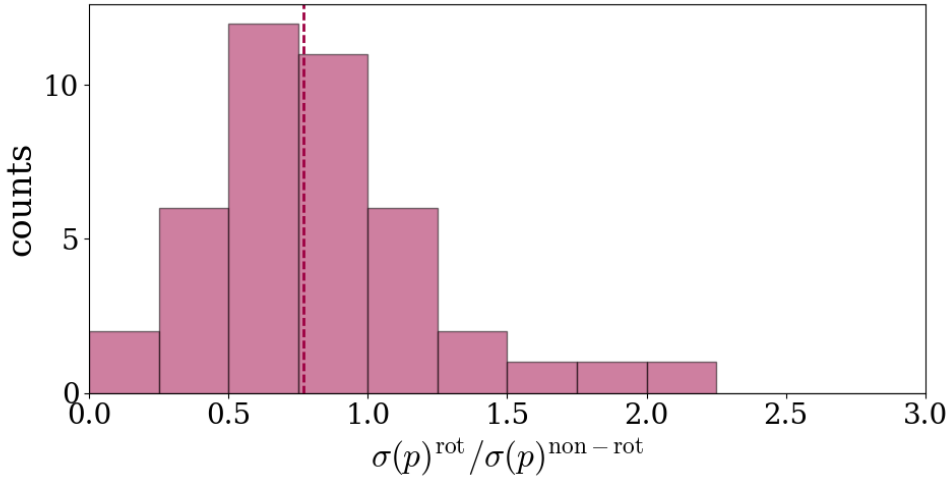


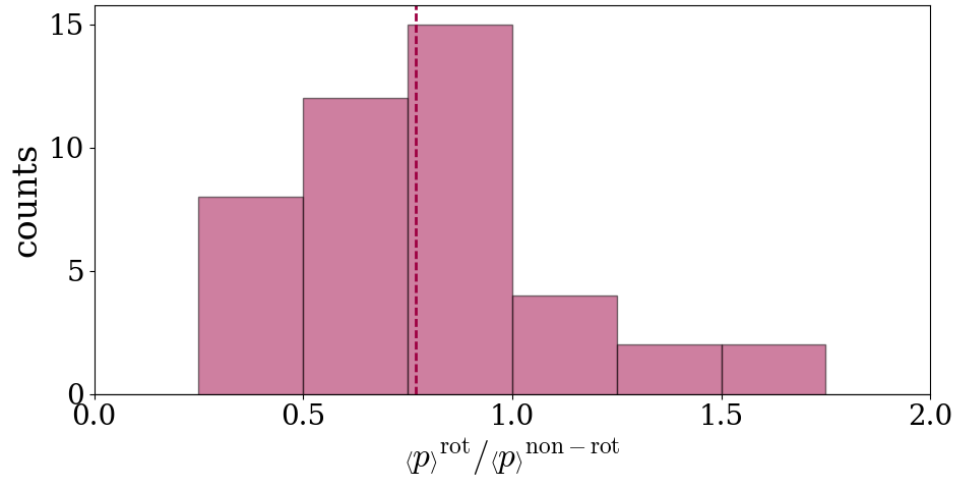
1. Polarization fraction drops during rotations

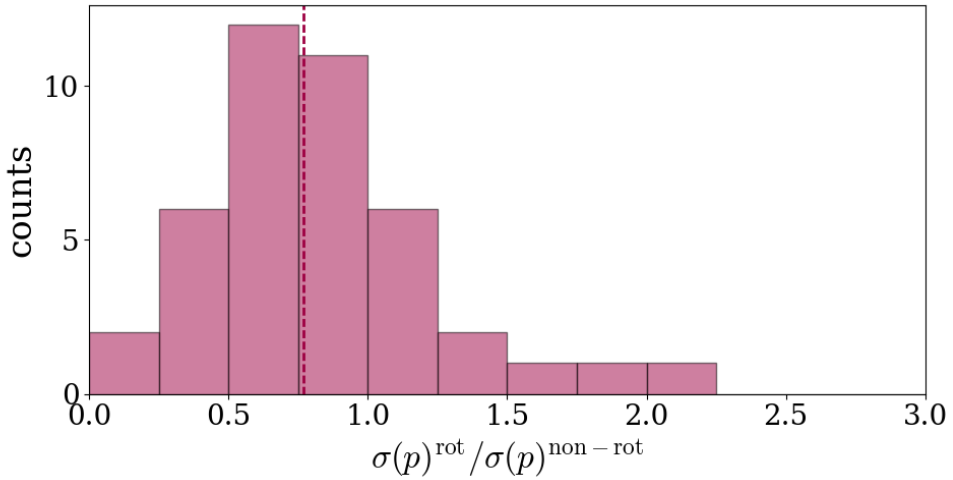
(Blinov et al. 2016a)

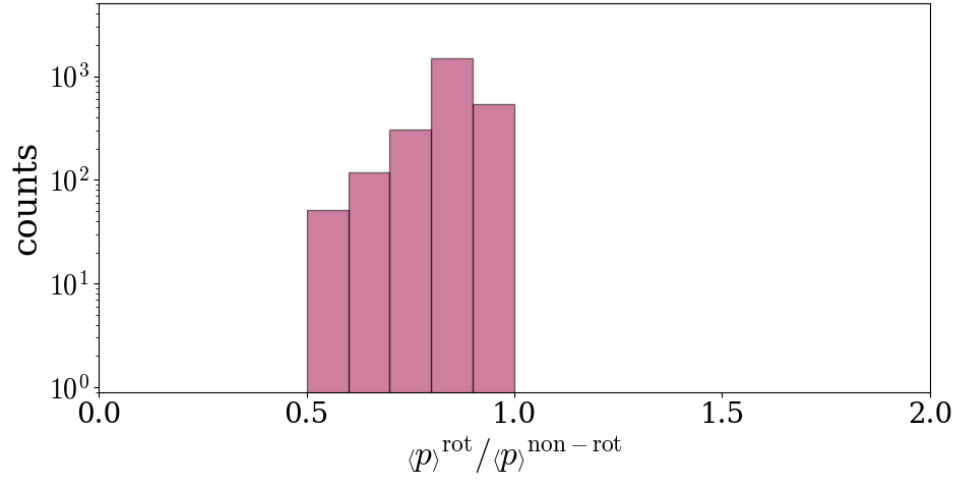

20
15
10
5
0
p [%]
270
180
90
0
χ [deg]
RBPLJ1800+7828
6500
6600
6700
6800
6900
7000
7100
7200
7300
JD − 2 450 000

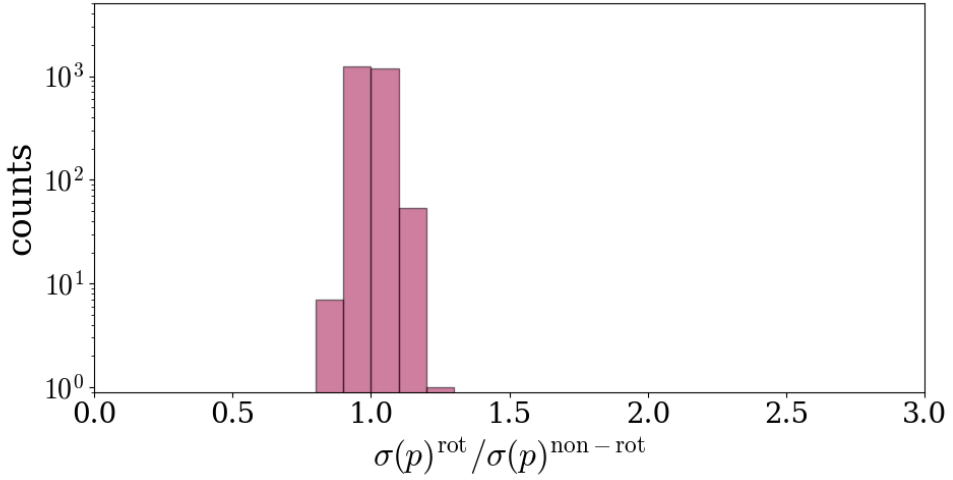

counts
15
10
5
0
0.0
0.5
1.0
1.5
2.0
$\langle p \rangle^{\mathrm{rot}} / \langle p \rangle^{\mathrm{non-rot}}$


counts
10
5
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
$\sigma(p)^{\mathrm{rot}} / \sigma(p)^{\mathrm{non-rot}}$


counts
$\langle p \rangle^{\mathrm{rot}} / \langle p \rangle^{\mathrm{non-rot}}$

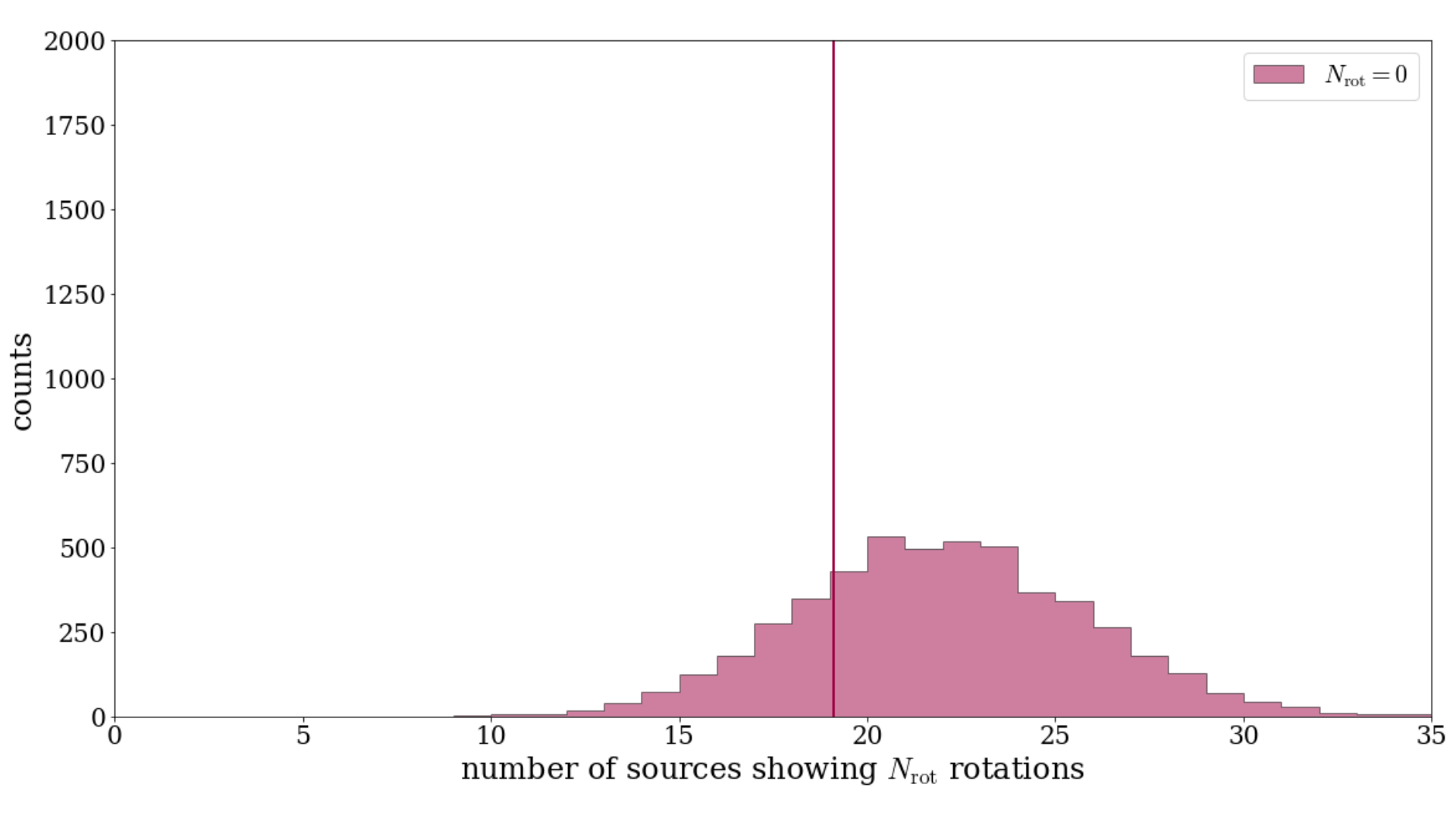

counts
$\sigma(p)^{\mathrm{rot}} / \sigma(p)^{\mathrm{non-rot}}$

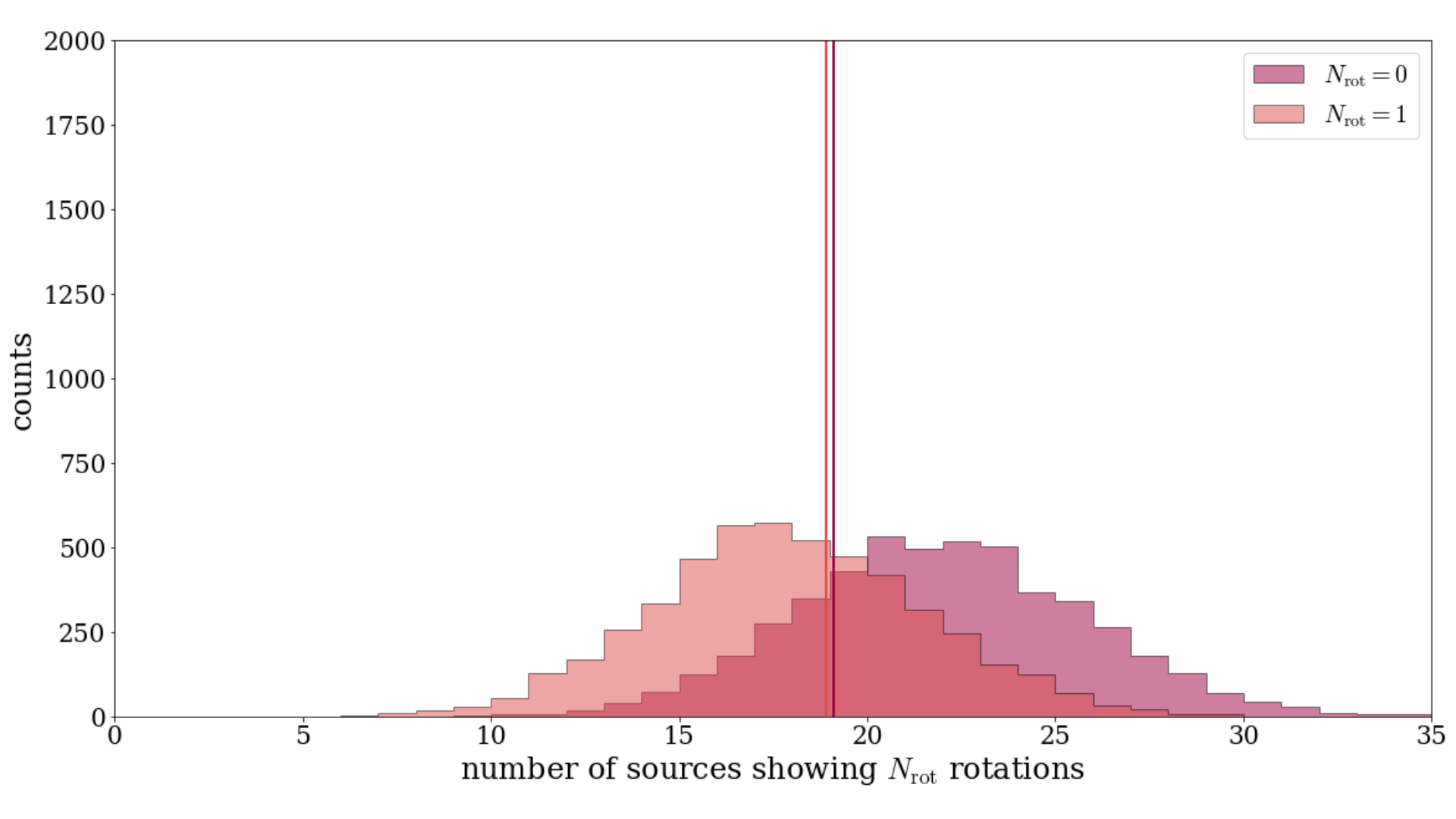

counts
$\langle p \rangle^{\mathrm{rot}} / \langle p \rangle^{\mathrm{non-rot}}$

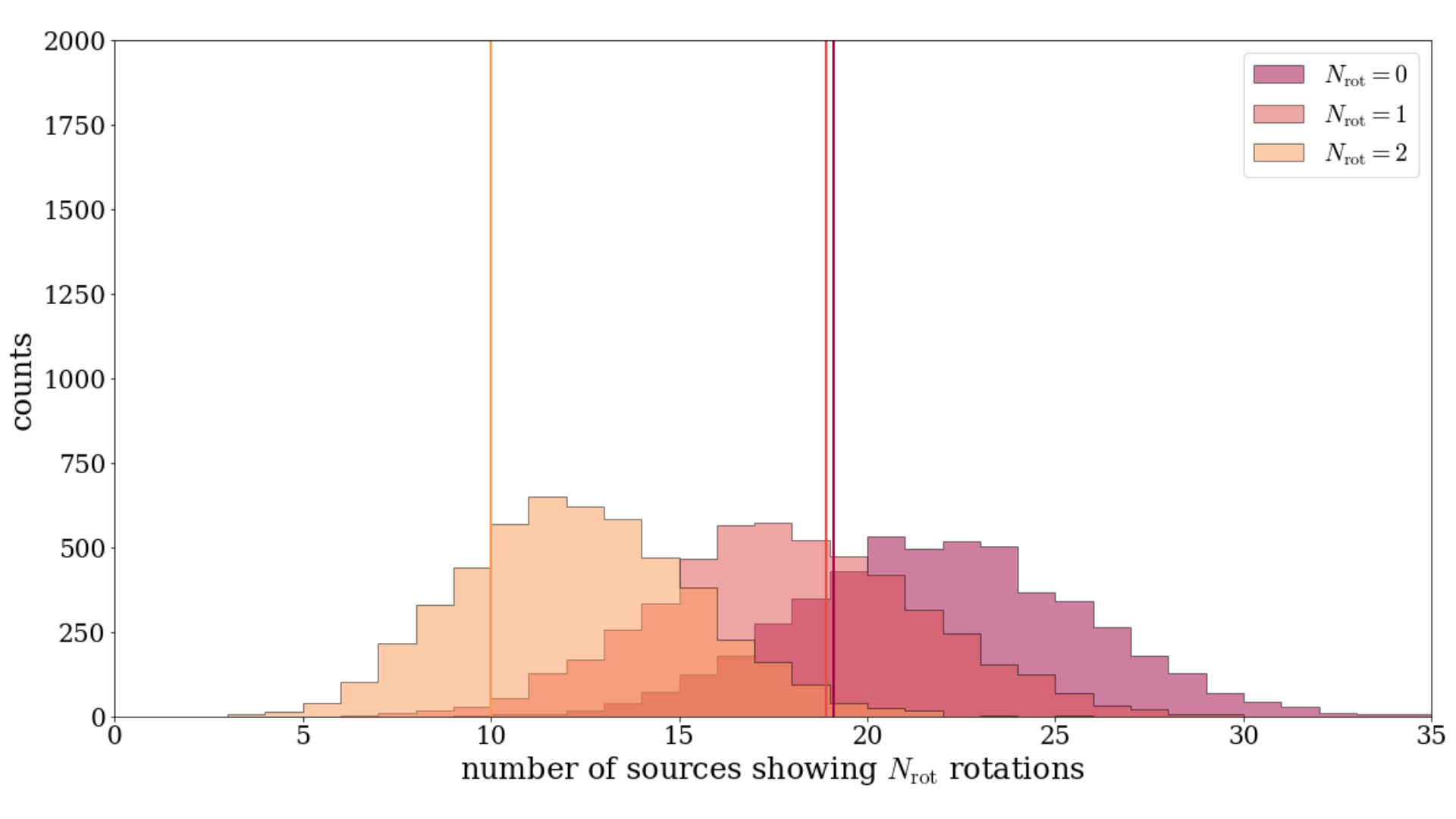

counts
$\sigma(p)^{\mathrm{rot}} / \sigma(p)^{\mathrm{non-rot}}$

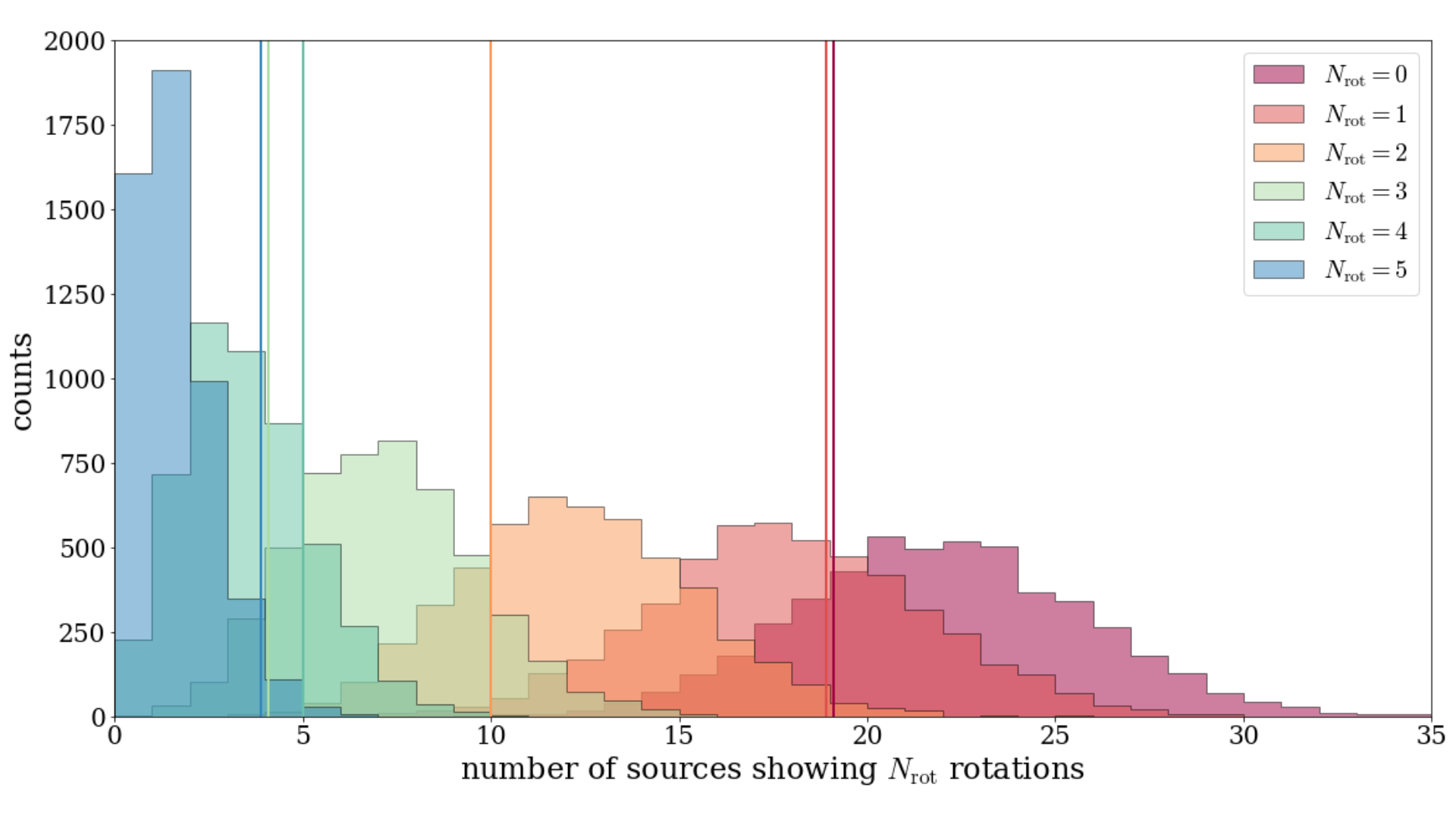
2. Some blazars do not rotate the EVPA

(Blinov et al. 2016b)

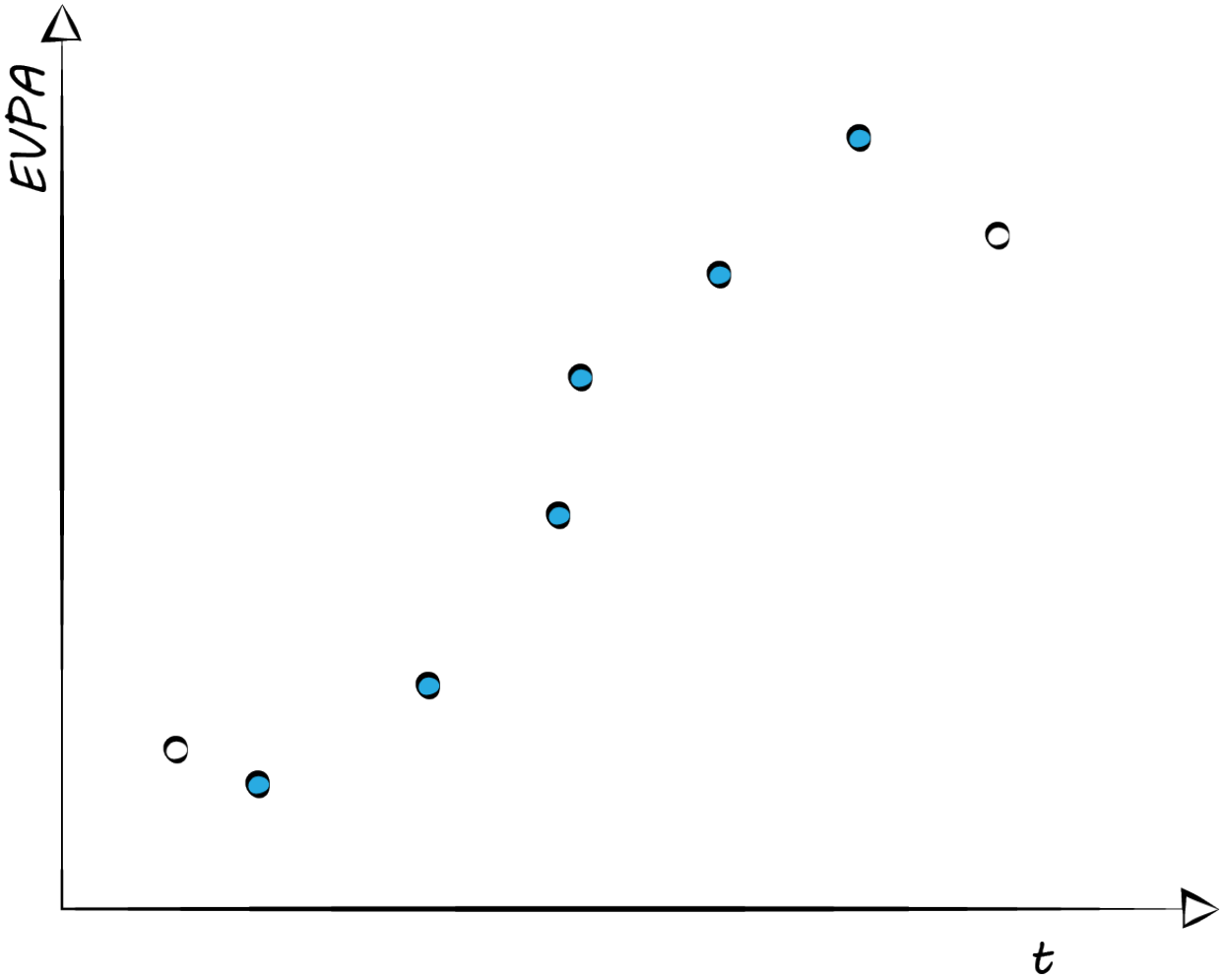

$N_{\mathrm{rot}} = 0$
counts
number of sources showing N_{rot} rotations
0
250
500
750
1000
1250
1500
1750
2000
0
5
10
15
20
25
30
35

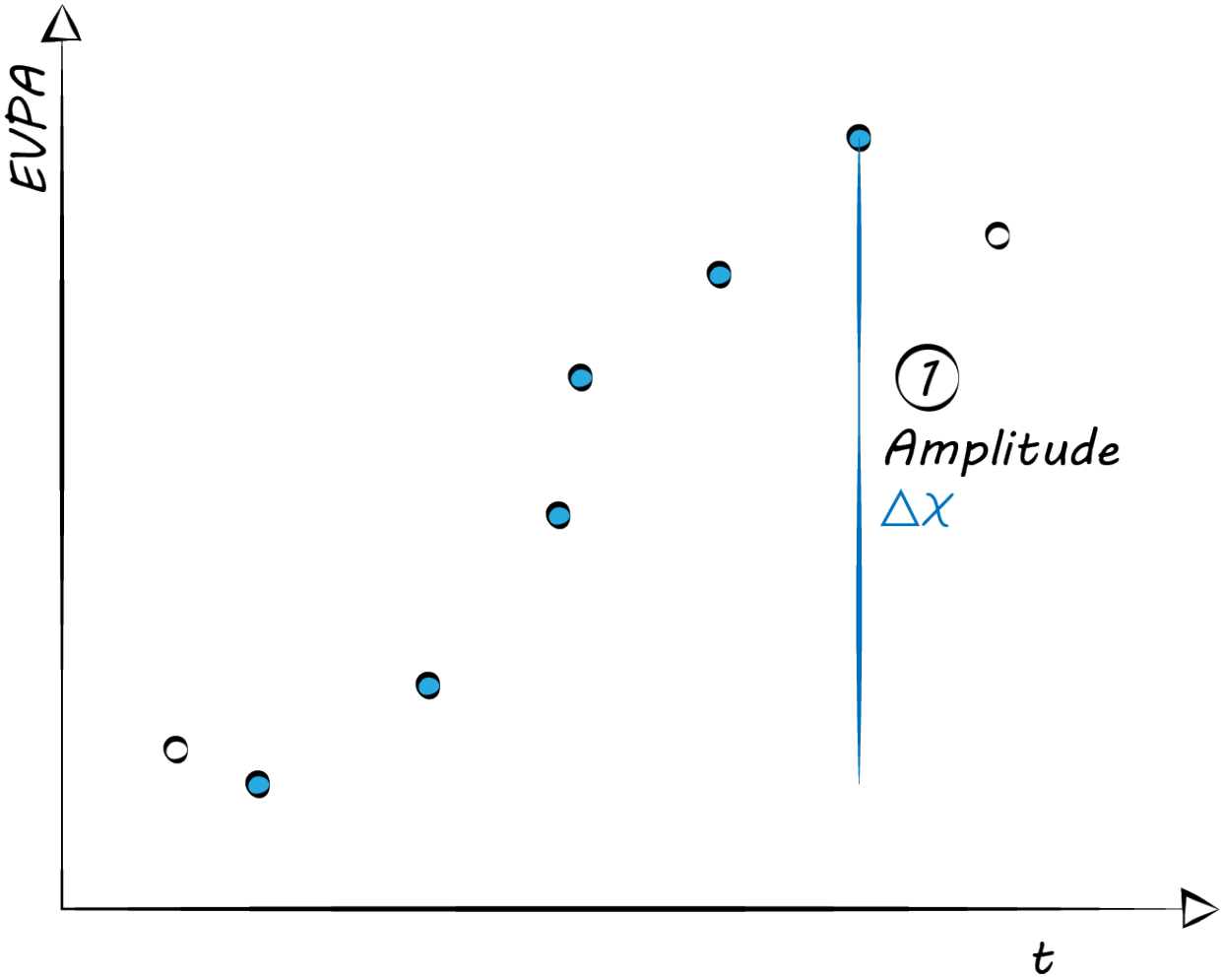

2000
1750
1500
1250
1000
750
500
250
0
counts
0
5
10
15
20
25
30
35
number of sources showing $N_{\rm rot}$ rotations
$N_{\rm rot} = 0$
$N_{\rm rot} = 1$

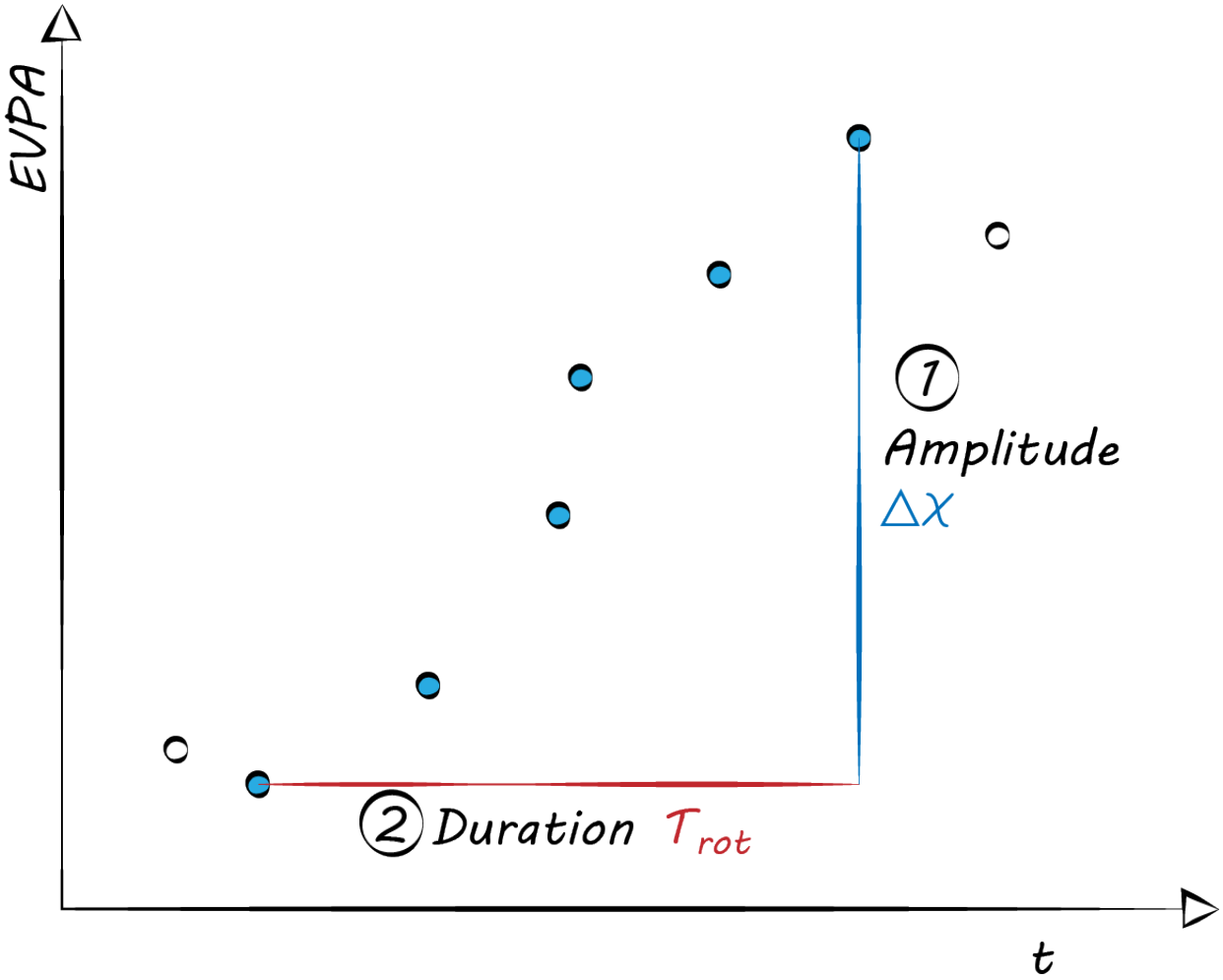

$N_{\rm rot} = 0$
$N_{\rm rot} = 1$
$N_{\rm rot} = 2$
counts
number of sources showing $N_{\rm rot}$ rotations
0
250
500
750
1000
1250
1500
1750
2000
0
5
10
15
20
25
30
35

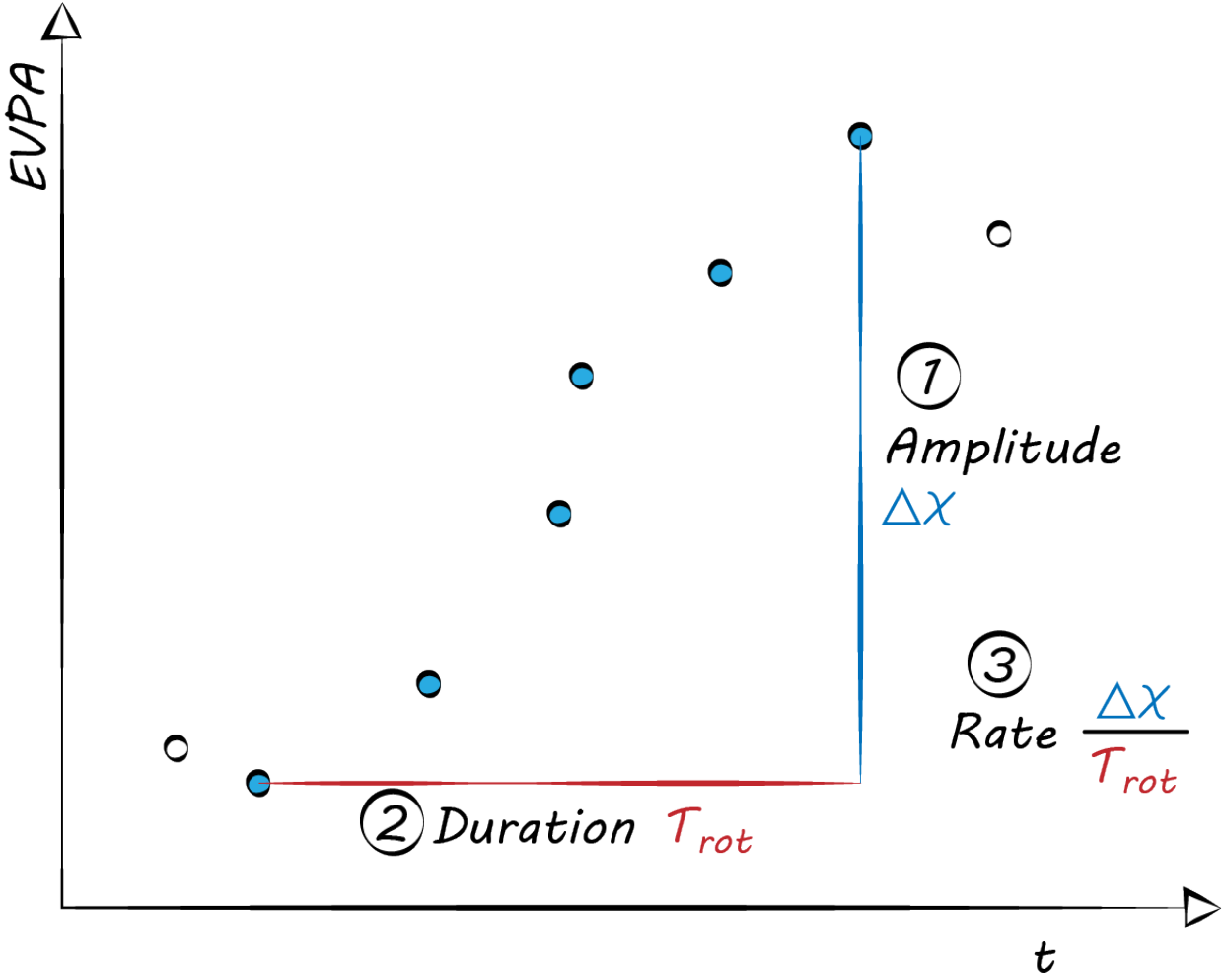

counts
number of sources showing $N_{\rm rot}$ rotations
$N_{\rm rot} = 0$
$N_{\rm rot} = 1$
$N_{\rm rot} = 2$
$N_{\rm rot} = 3$
$N_{\rm rot} = 4$
$N_{\rm rot} = 5$
0
250
500
750
1000
1250
1500
1750
2000
0
5
10
15
20
25
30
35

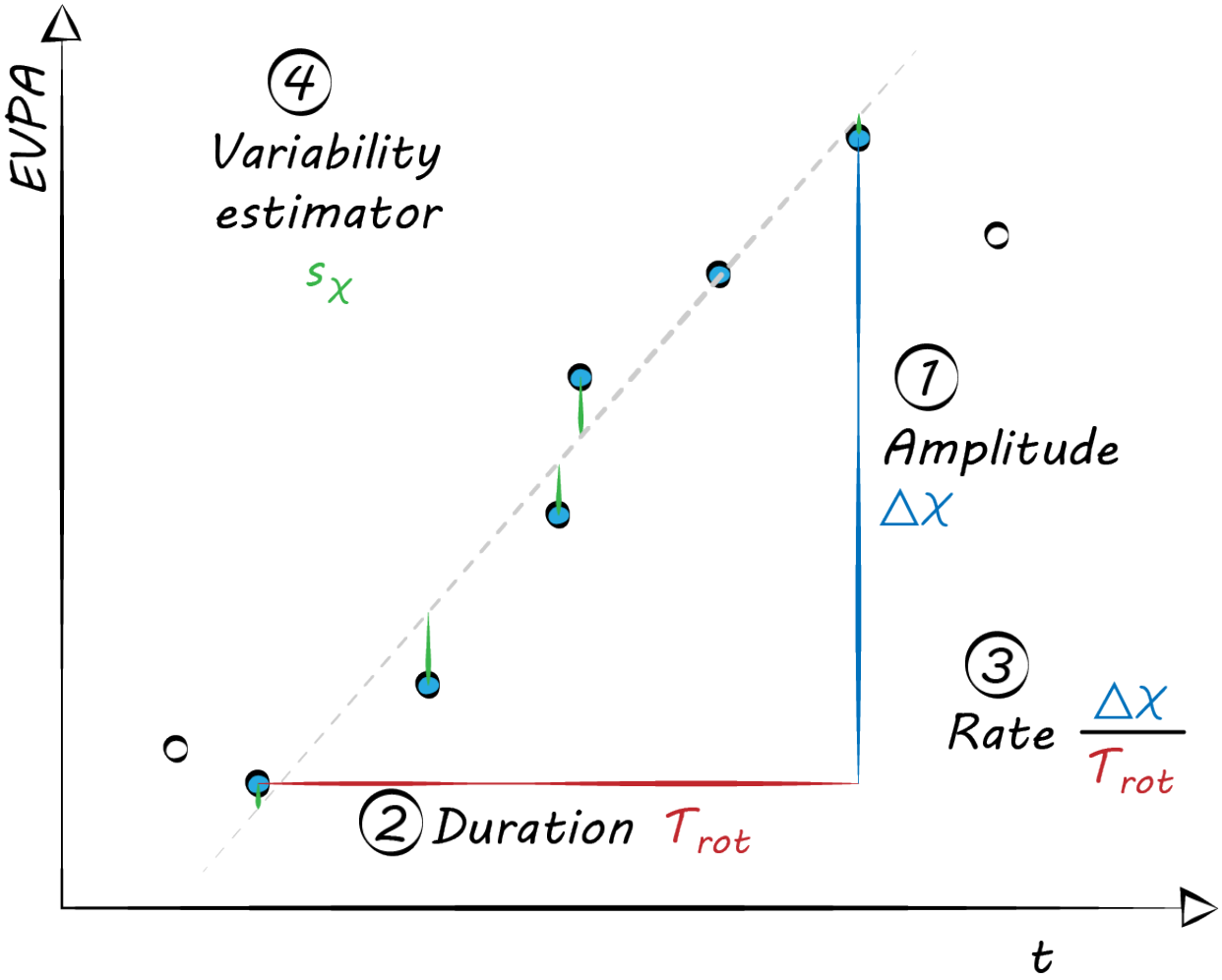
3. Rotation characteristics

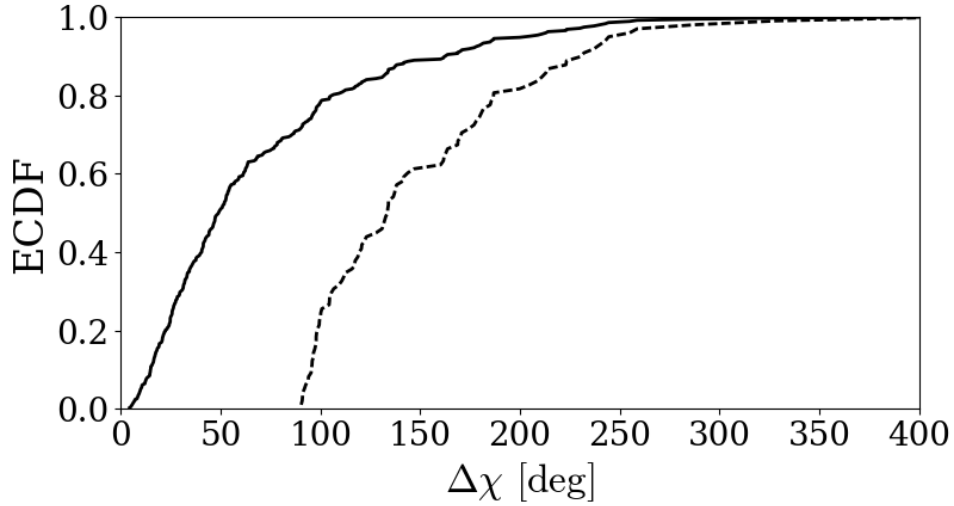

EVPA
t

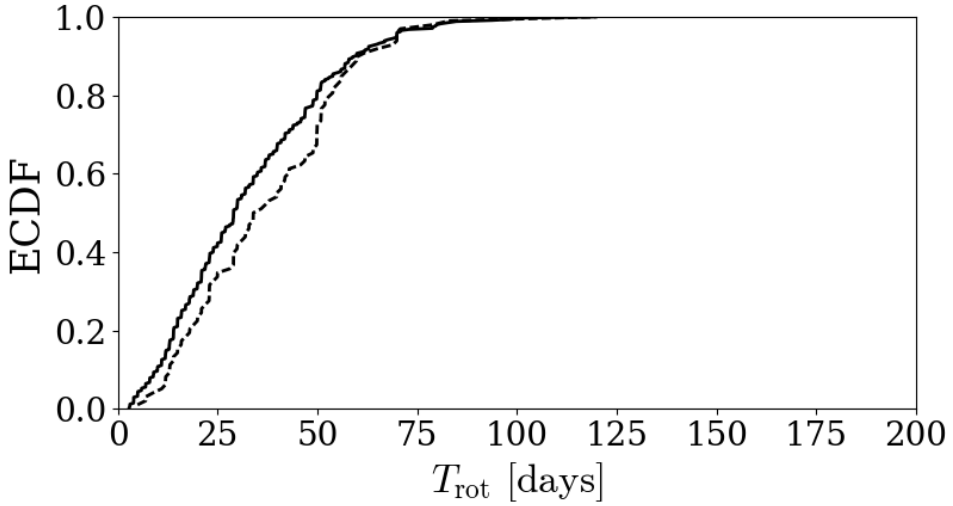

EVPA
1
Amplitude
ΔX
t

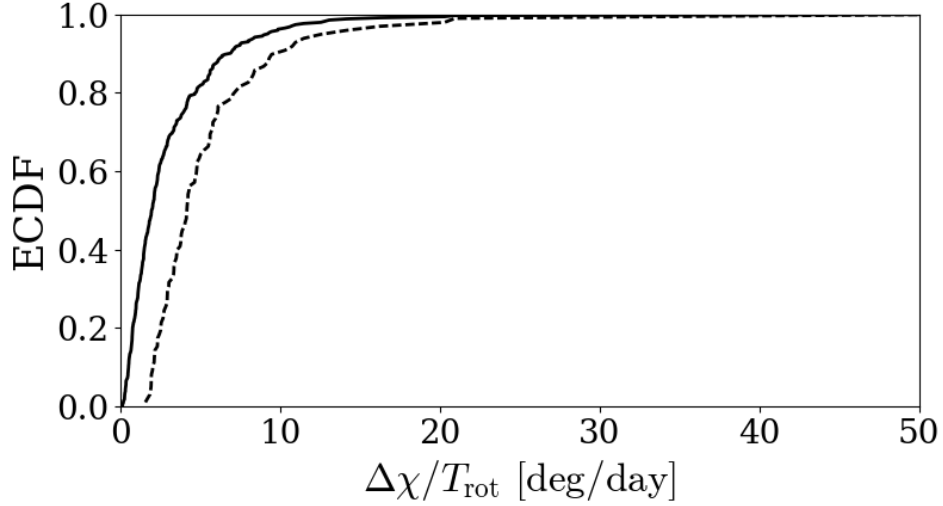

EVPA
1
Amplitude
ΔX
2 Duration T_{rot}
t

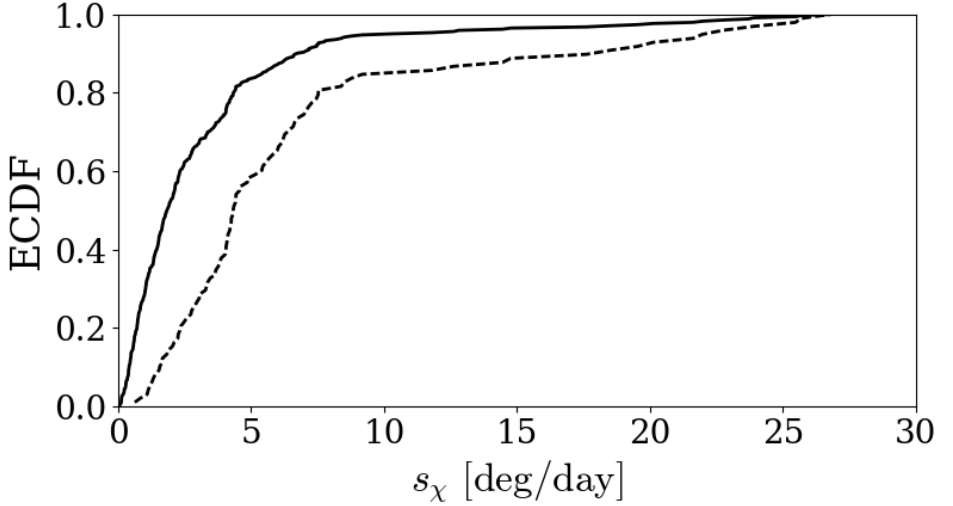

EVPA
t
1
Amplitude
ΔX
2 Duration T_{rot}
3
Rate $\frac{\Delta X}{T_{rot}}$

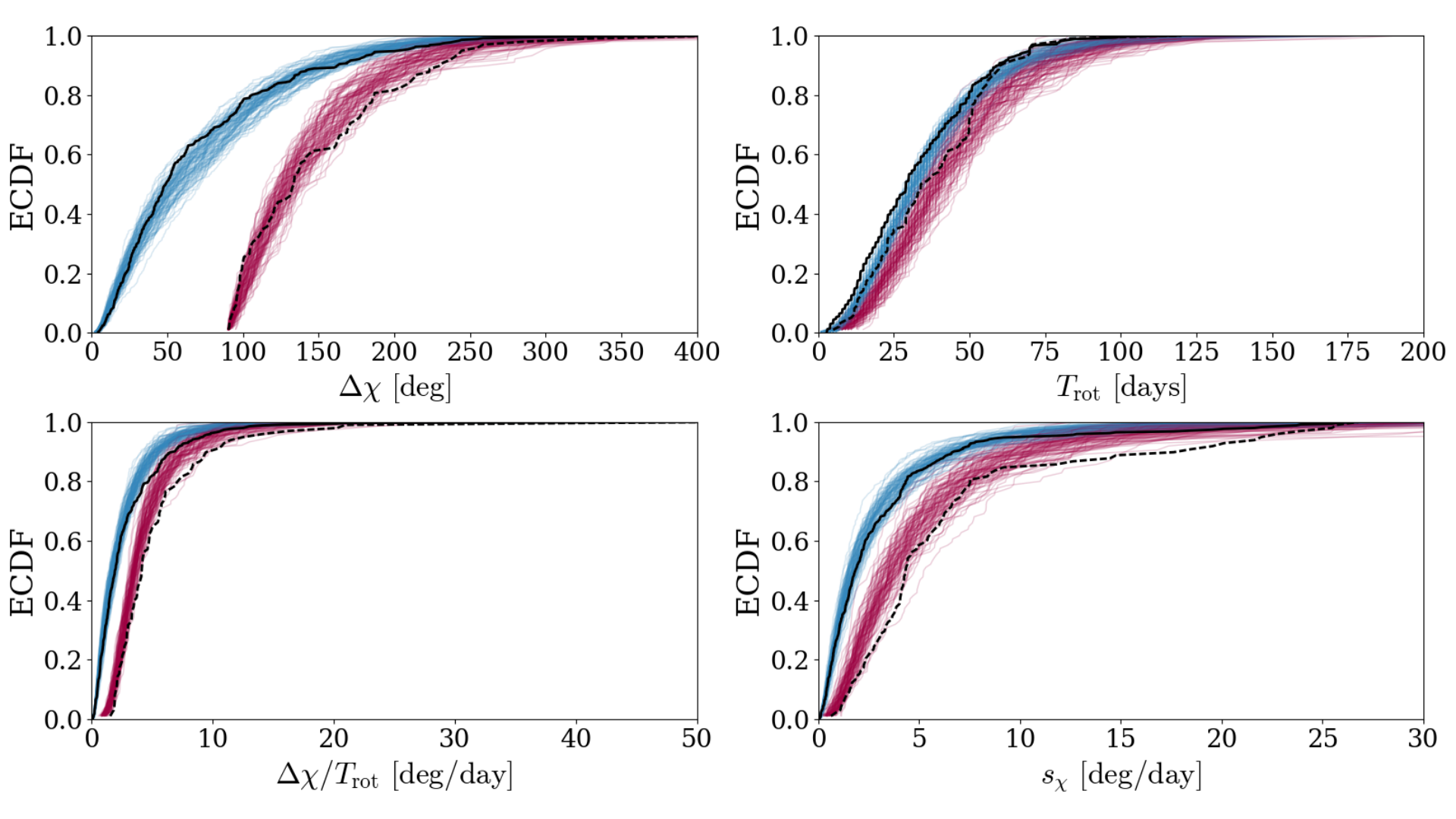

EVPA
4
Variability
estimator
s_X
1
Amplitude
ΔX
3
Rate $\frac{\Delta X}{T_{rot}}$
2 Duration T_{rot}
t

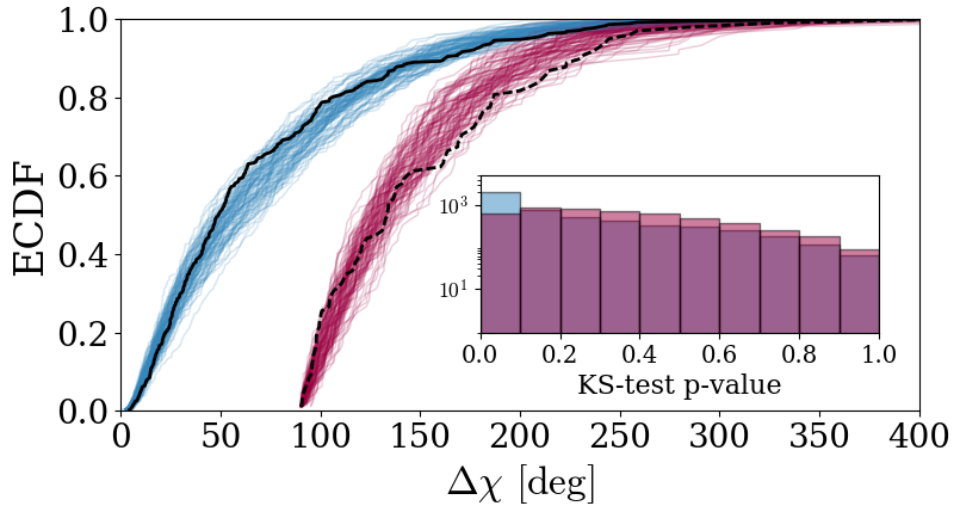

ECDF
1.0
0.8
0.6
0.4
0.2
0.0
0
50
100
150
200
250
300
350
400
$\Delta\chi$ [deg]

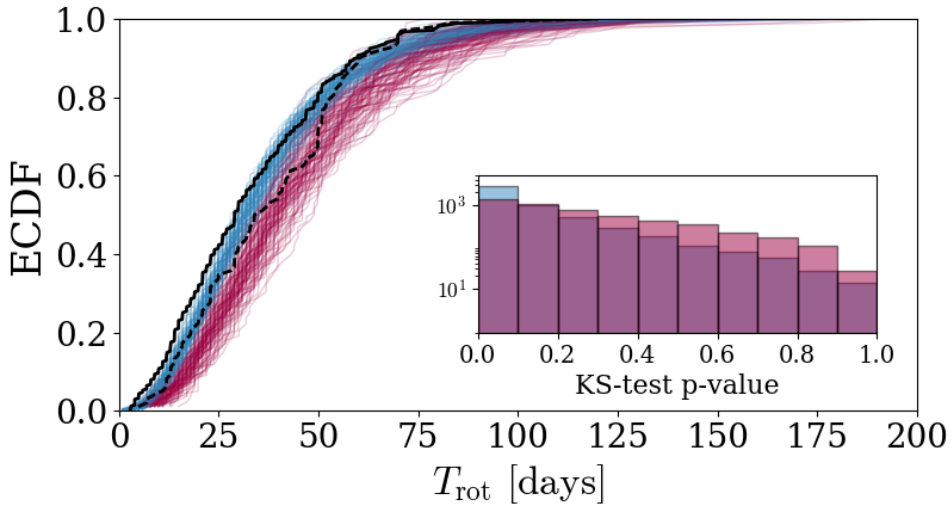

ECDF
1.0
0.8
0.6
0.4
0.2
0.0
0
25
50
75
100
125
150
175
200
$T_{\rm rot}$ [days]

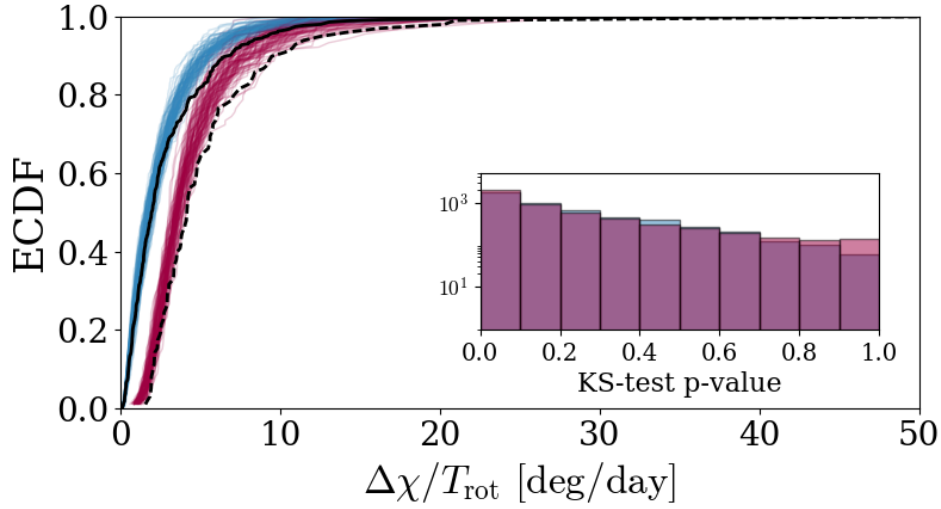

ECDF
1.0
0.8
0.6
0.4
0.2
0.0
0
10
20
30
40
50
$\Delta\chi/T_{\rm rot}$ [deg/day]

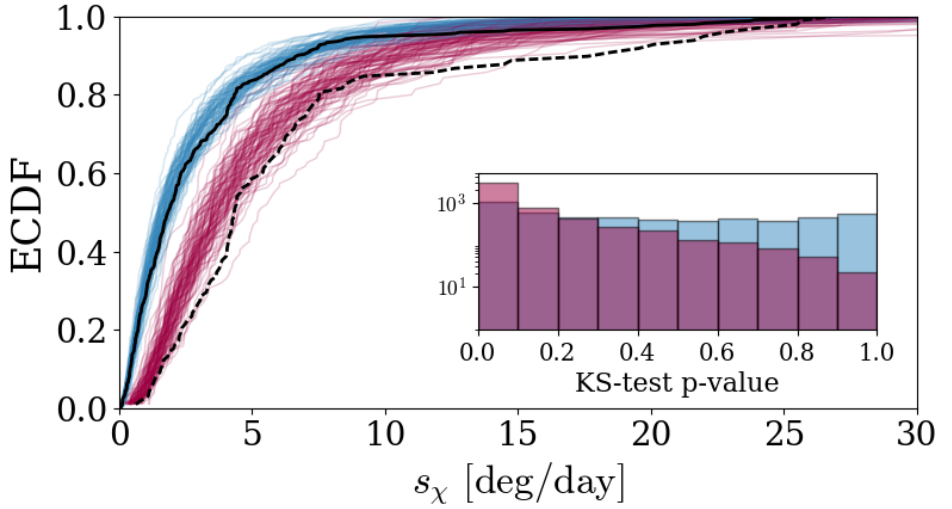

ECDF
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
s_χ [deg/day]


ECDF
$\Delta\chi$ [deg]
$T_{\rm rot}$ [days]
$\Delta\chi/T_{\rm rot}$ [deg/day]
s_χ [deg/day]

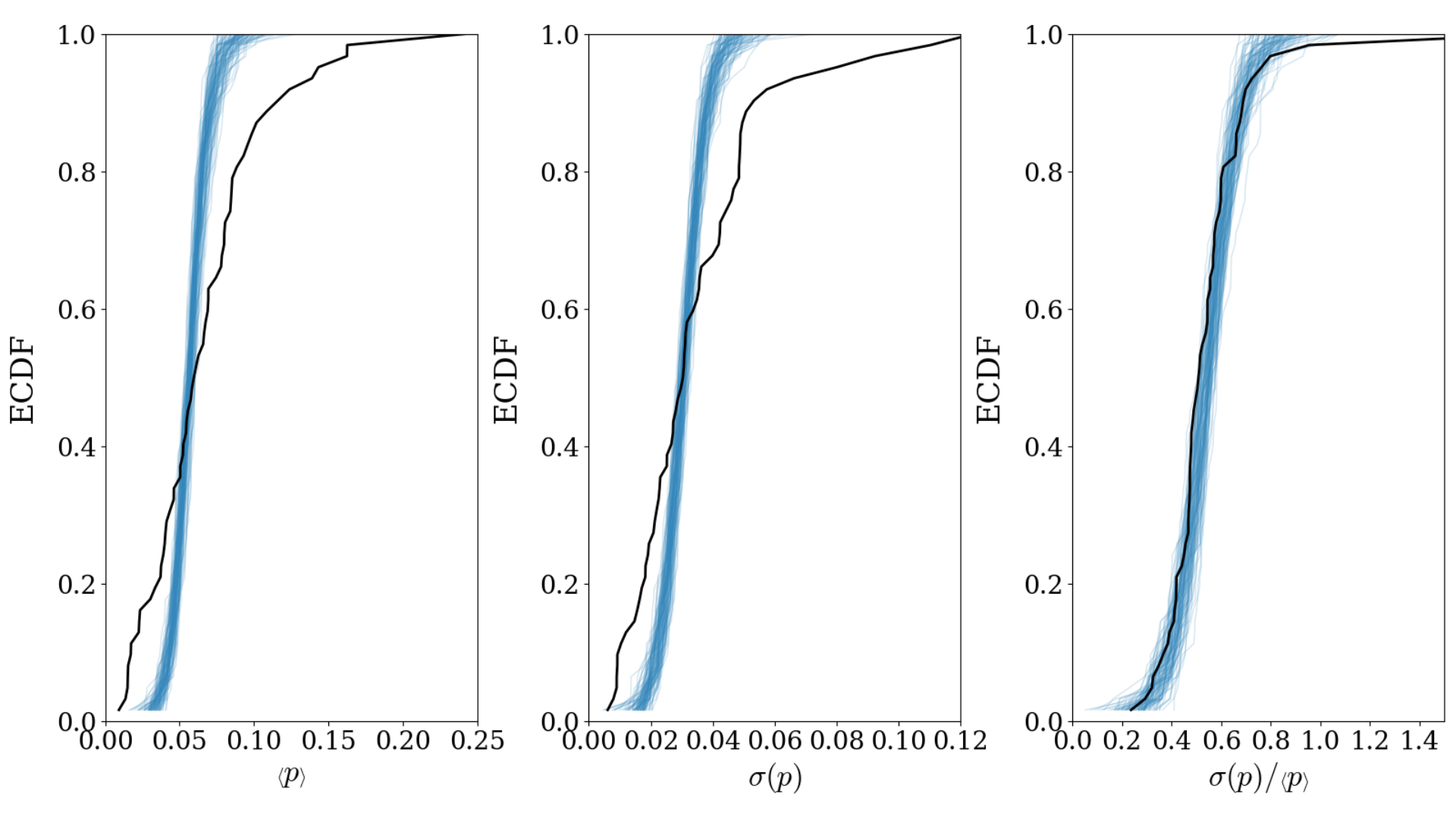

ECDF
$\Delta\chi$ [deg]
KS-test p-value

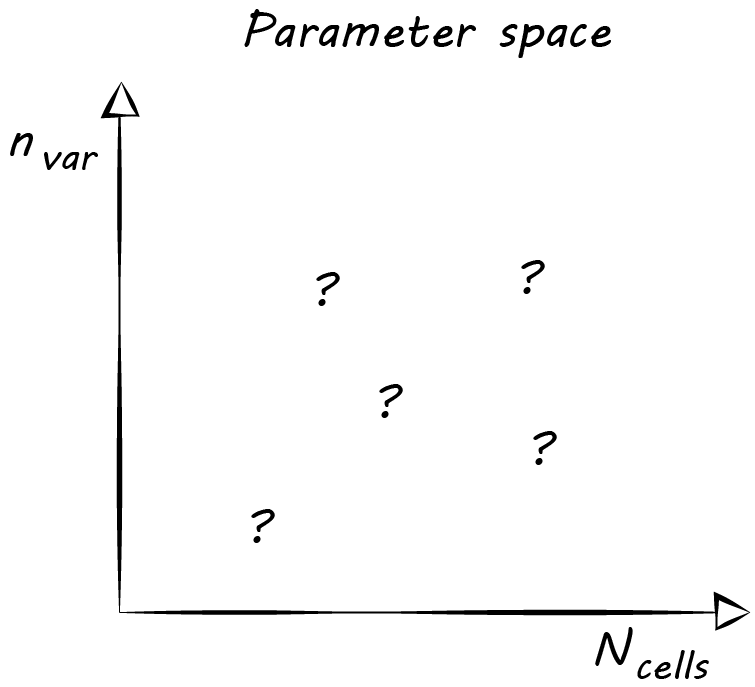

ECDF
$T_{\rm rot}$ [days]
KS-test p-value

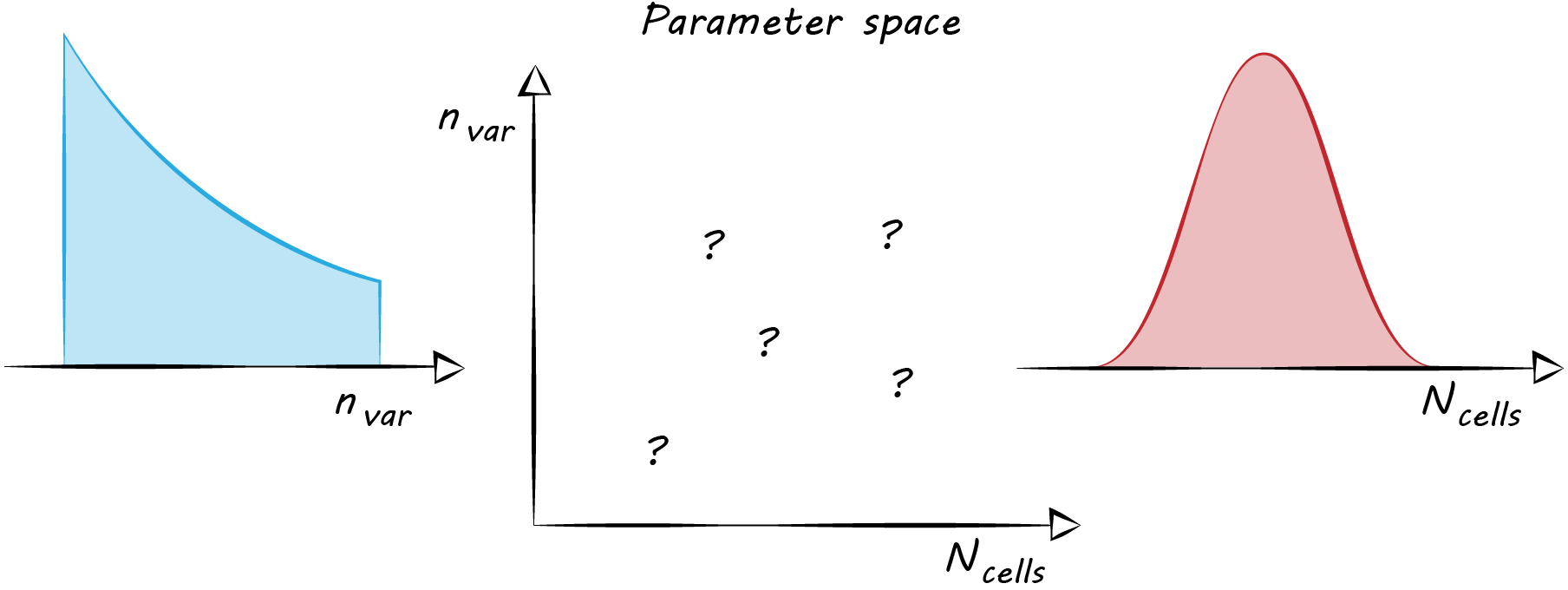

ECDF
$\Delta\chi/T_{\rm rot}$ [deg/day]
KS-test p-value


ECDF
s_χ [deg/day]
KS-test p-value

4. Fractional polarization


ECDF
1.0
0.8
0.6
0.4
0.2
0.0
0.00 0.05 0.10 0.15 0.20 0.25
⟨p⟩
ECDF
0.00 0.02 0.04 0.06 0.08 0.10 0.12
σ(p)
ECDF
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4
σ(p)/⟨p⟩


Parameter space
n_{var}
?
?
?
?
?
N_{cells}


Parameter space
n_{var}
n_{var}
?
?
?
?
?
N_{cells}
N_{cells}

Summary

Observation	**Random walk simulation**
1. Polarization fraction drops during rotations	✓
2. Some blazars do not rotate the EVPA	✓
3. Rotation characteristics	(✓)
4. Fractional polarization	✗