Haakon Andresen

The Power Gap in 2D

The Gravitational-Wave Power Gap in Core-Collapse Supernovae: Insights from 60 Axisymmetric Simulations

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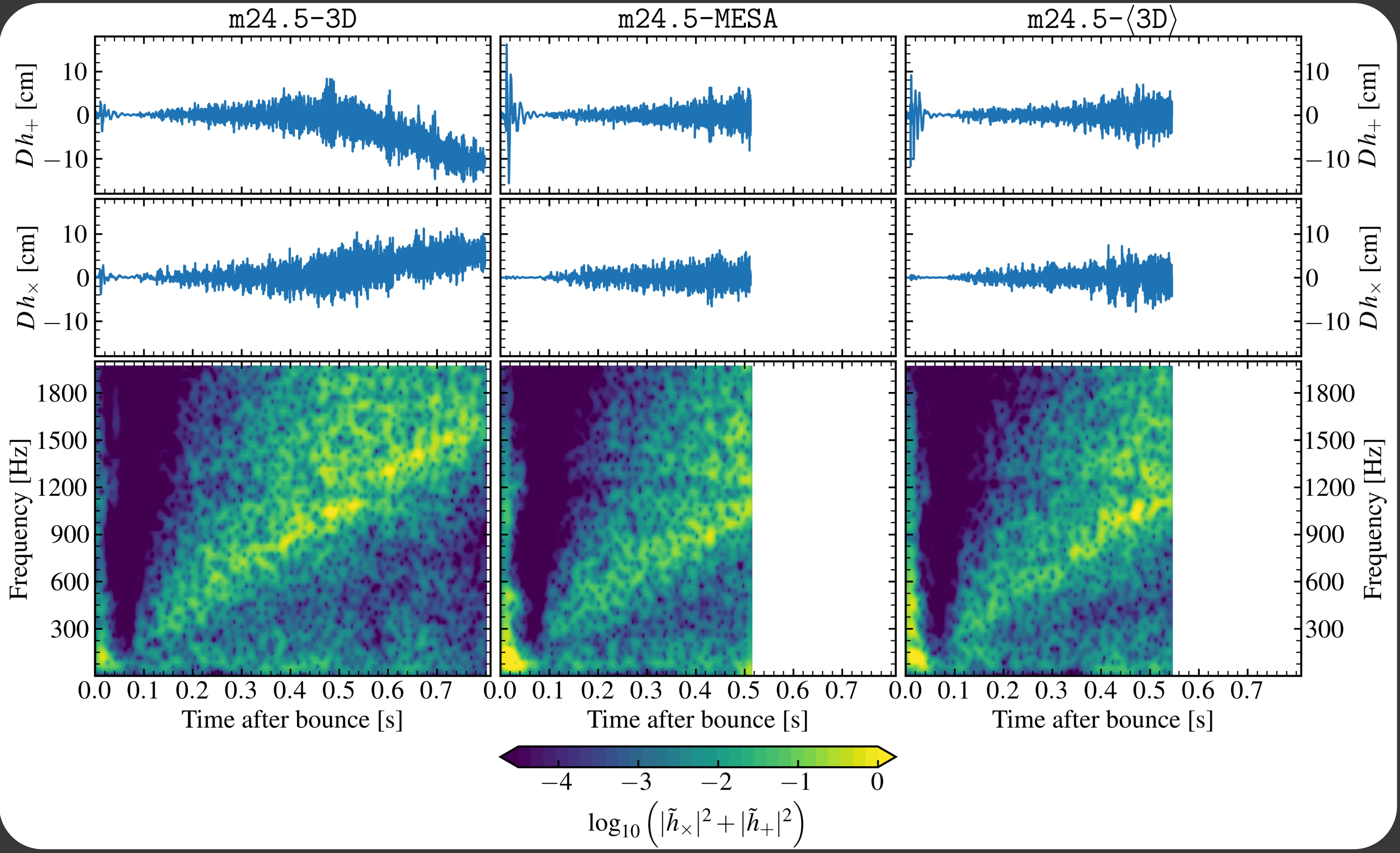
CCSN GWs

- Broad band
- Stochastic
- Turbulent forcing

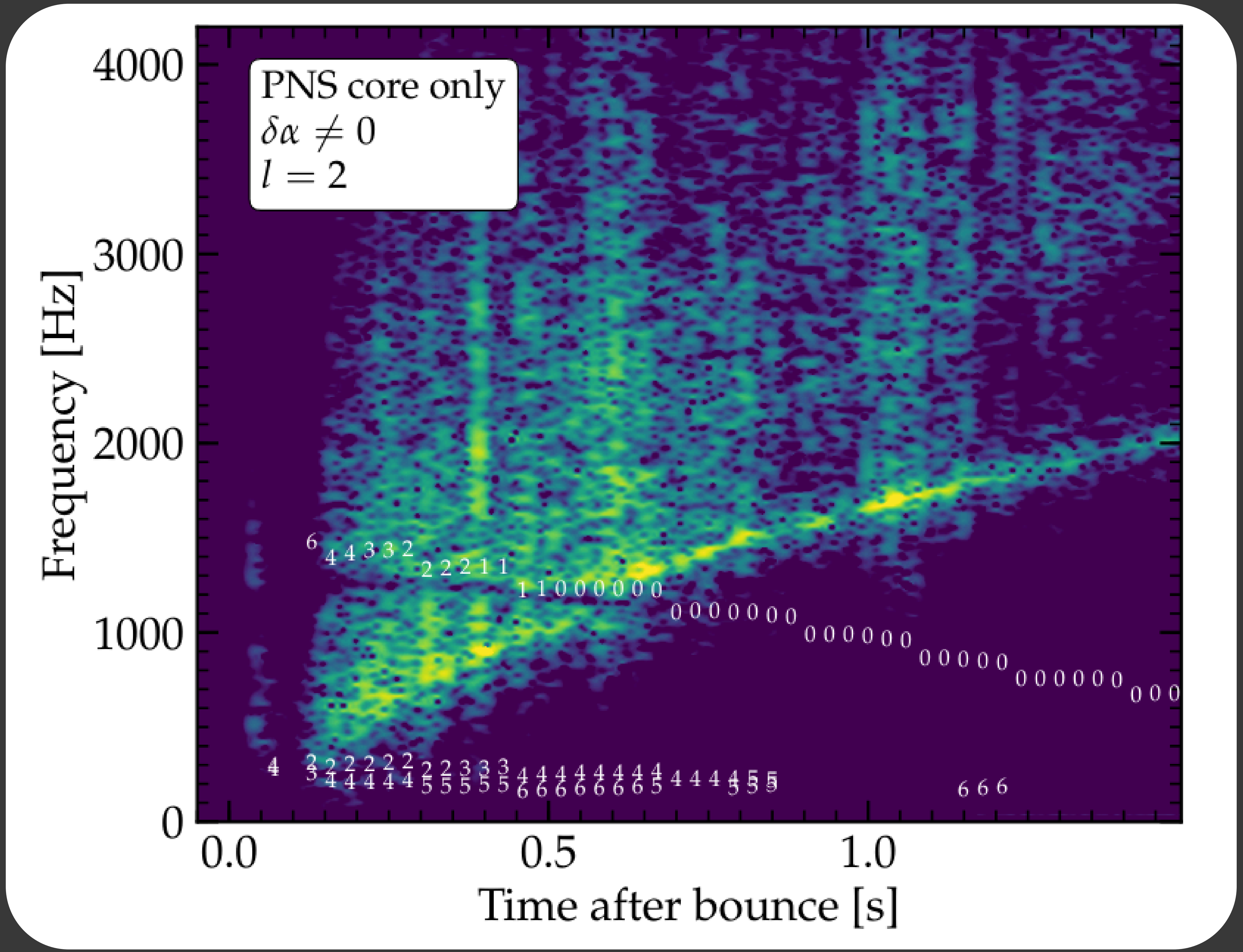


What is the power gap?

- A decrease in gravitational-wave energy
- Seen in most modern models
- Related to the protoneutron star
- Morozova (2018)

Where does it come from?

- Avoided crossing
- Quadrupole integral (Zha 2024)
- Something else?

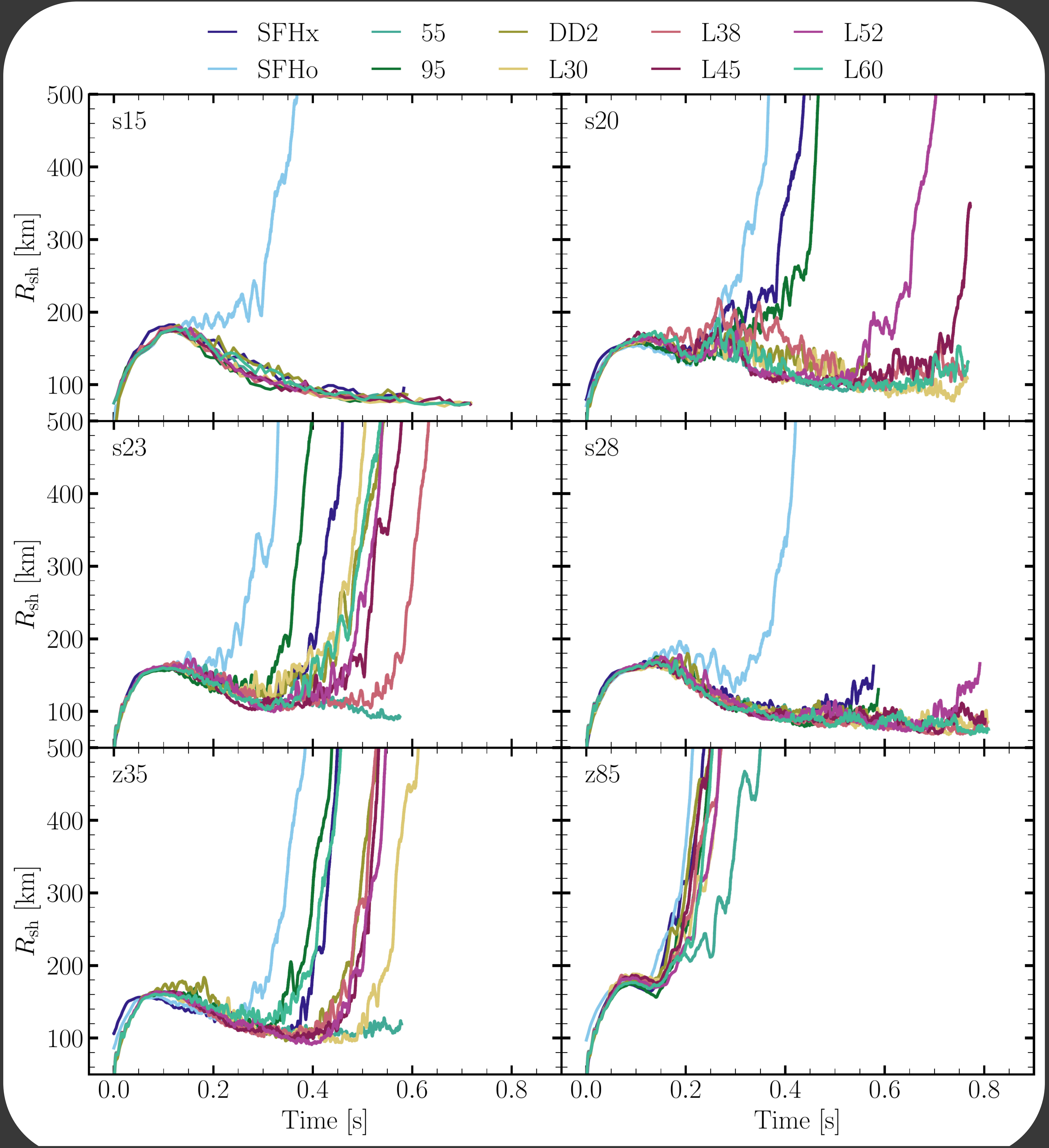


Morozova+2018

Simulations

60 2D simulations

- 6 Progenitors
- 10 EOS variations



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Model	Power Gap [Hz]	Shock Revival [s]	End [s]	BH	Model	Power Gap [Hz]	Shock Revival [s]	End [s]	BH
s15_SFHx	1229	–	0.58	No	s23_SFHx	–	0.42	0.54	No
s15_SFHo	1200	0.31	0.52	No	s23_SFHo	1307	0.28	0.50	No
s15_55	1127	–	0.56	No	s23_55	1197	–	0.57	No
s15_95	1159	–	0.53	No	s23_95	1315	0.37	0.52	No
s15_DD2	1078	–	0.59	No	s23_DD2	1144	0.48	0.55	No
s15_L30	1200	–	0.72	No	s23_L30	1350	0.48	0.70	No
s15_L38	1200	–	0.54	No	s23_L38	1300	0.60	0.65	No
s15_L45	1100	–	0.72	No	s23_L45	1350	0.52	0.73	No
s15_L52	1100	–	0.39	No	s23_L52	1300	0.51	0.71	No
s15_L60	1100	–	0.71	No	s23_L60	1275	0.49	0.71	No
s20_SFHx	1300	0.39	0.53	No	s28_SFHx	1350	–	0.58	No
s20_SFHo	1270	0.32	0.48	No	s28_SFHo	1248	0.39	0.54	No
s20_55	1172	–	0.58	No	s28_55	1170	–	0.59	No
s20_95	1216	0.45	0.53	No	s28_95	1210	–	0.59	No
s20_DD2	1129	–	0.57	No	s28_DD2	1171	–	0.59	No
s20_L30	1250	–	0.77	No	s28_L30	1200	–	0.81	No
s20_L38	1250	–	0.76	No	s28_L38	1200	–	0.81	No
s20_L45	1225	0.76	0.77	No	s28_L45	1200	–	0.80	No
s20_L52	1225	0.66	0.75	No	s28_L52	1150	–	0.79	No
s20_L60	1200	–	0.77	No	s28_L60	1150	–	0.81	No
z35_SFHx	1367	0.43	0.50	No	z85_SFHx	–	0.19	0.56	No
z35_SFHo	1367	0.35	0.54	No	z85_SFHo	–	0.19	0.37	Yes
z35_55	1200	–	0.58	No	z85_55	–	0.29	0.50	No
z35_95	1240	0.40	0.53	No	z85_95	–	0.22	0.44	Yes
z35_DD2	1157	0.50	0.56	No	z85_DD2	–	0.20	0.48	No
z35_L30	1400	0.57	0.73	No	z85_L30	–	0.22	0.62	No
z35_L38	1400	0.51	0.71	No	z85_L38	–	0.22	0.61	No
z35_L45	1400	0.52	0.71	No	z85_L45	–	0.21	0.61	No
z35_L52	1400	0.52	0.72	No	z85_L52	–	0.22	0.62	No
z35_L60	1350	0.42	0.68	No	z85_L60	–	0.23	0.62	No

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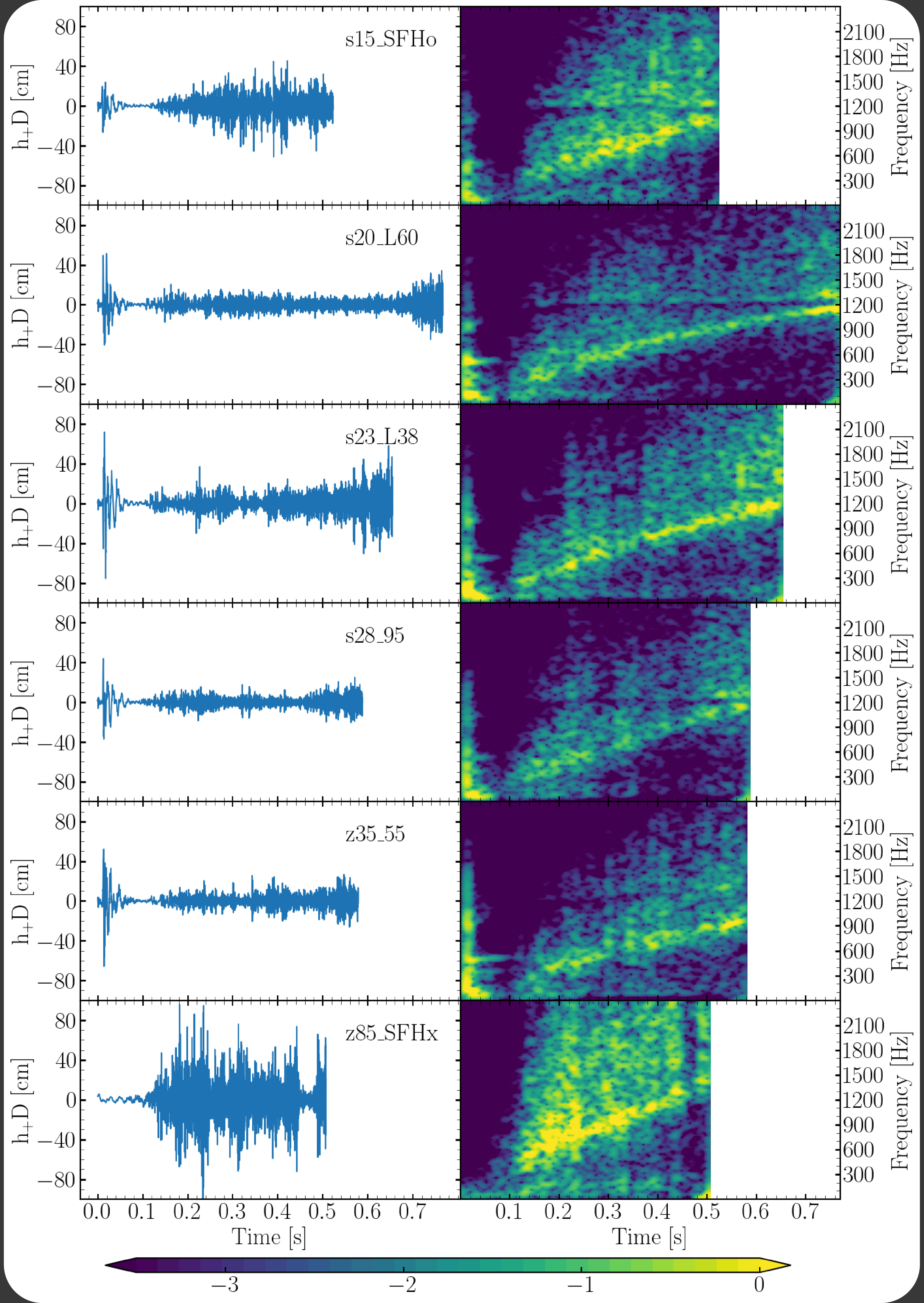
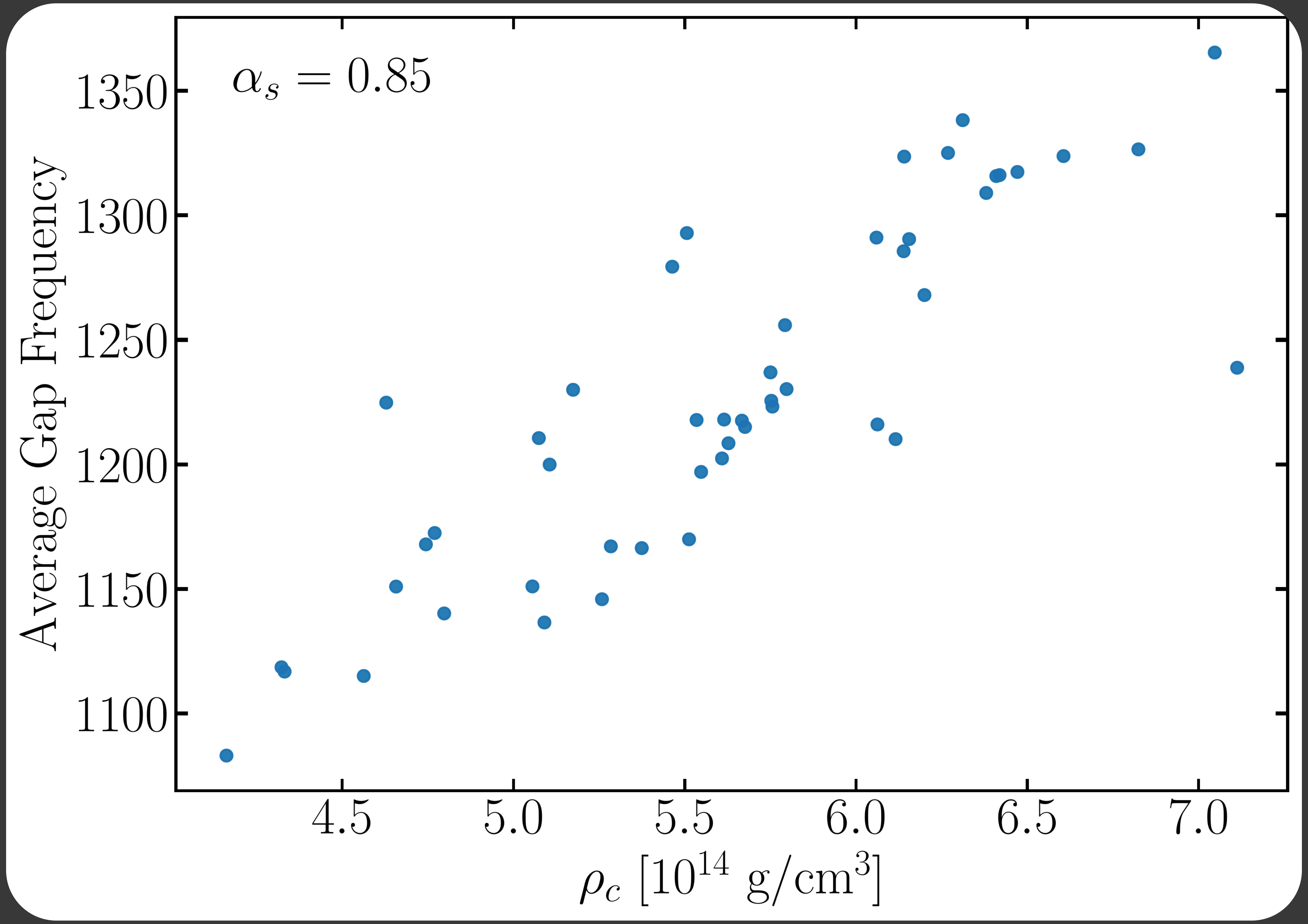
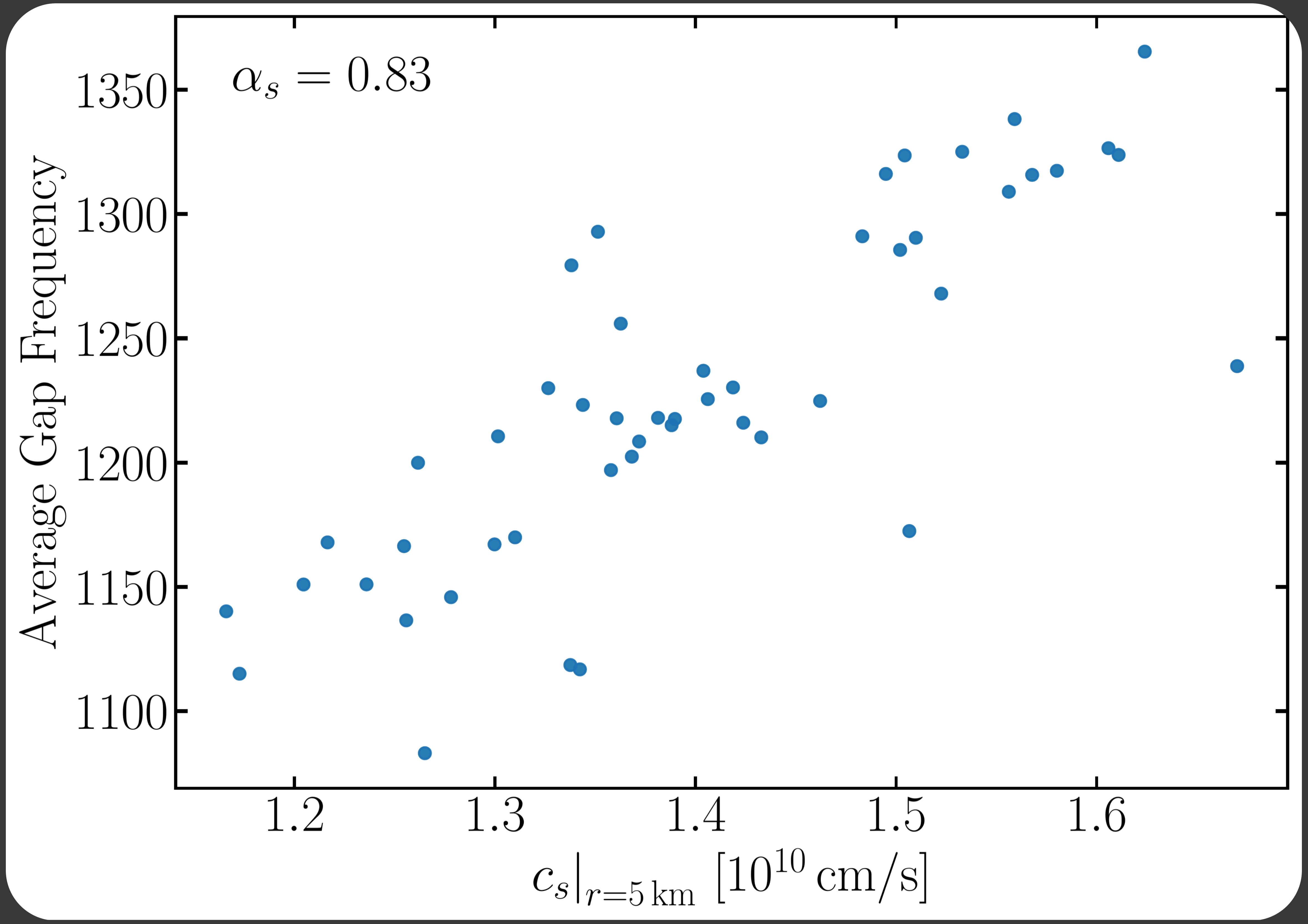


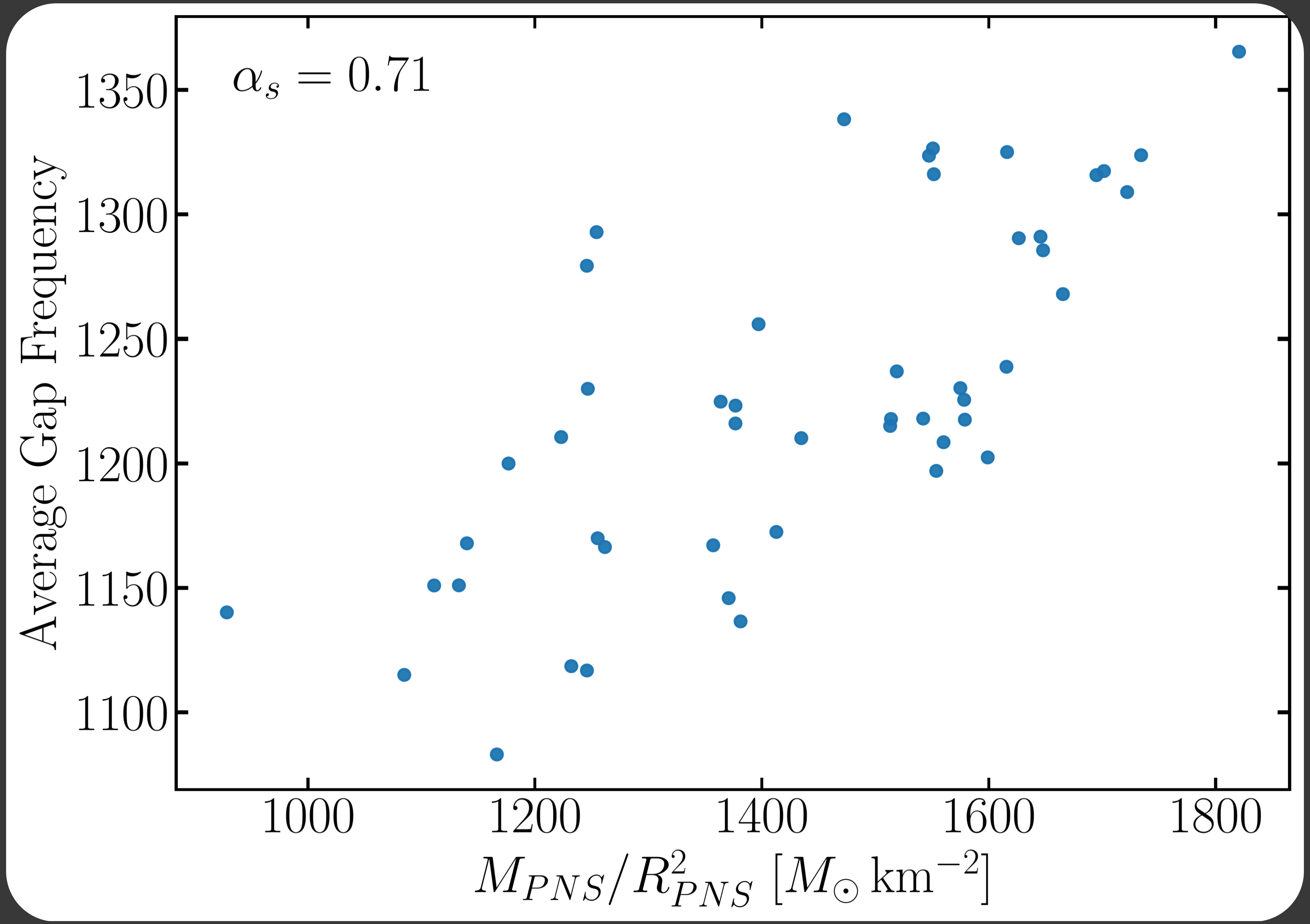
Physics

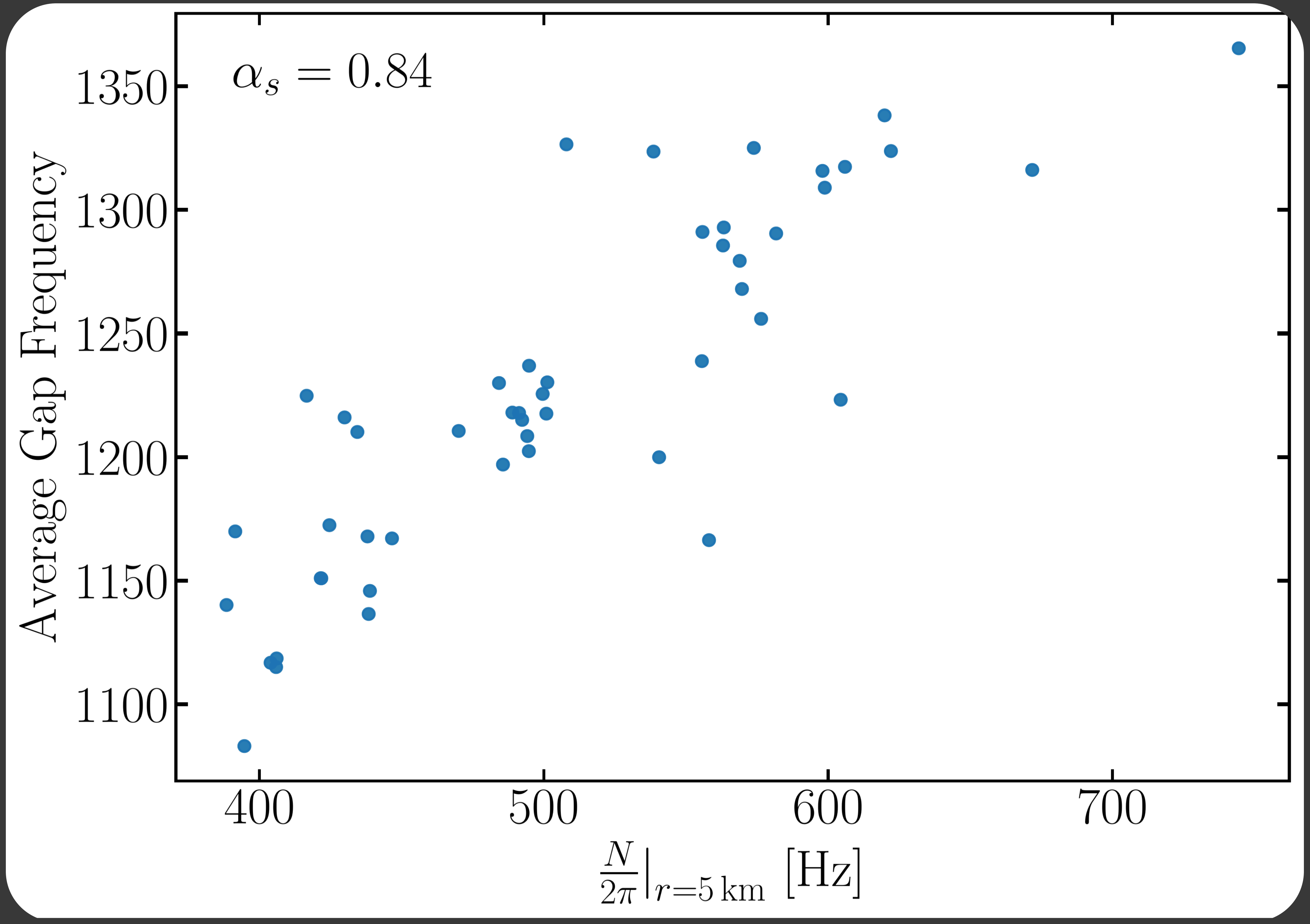
Correlation with Physics





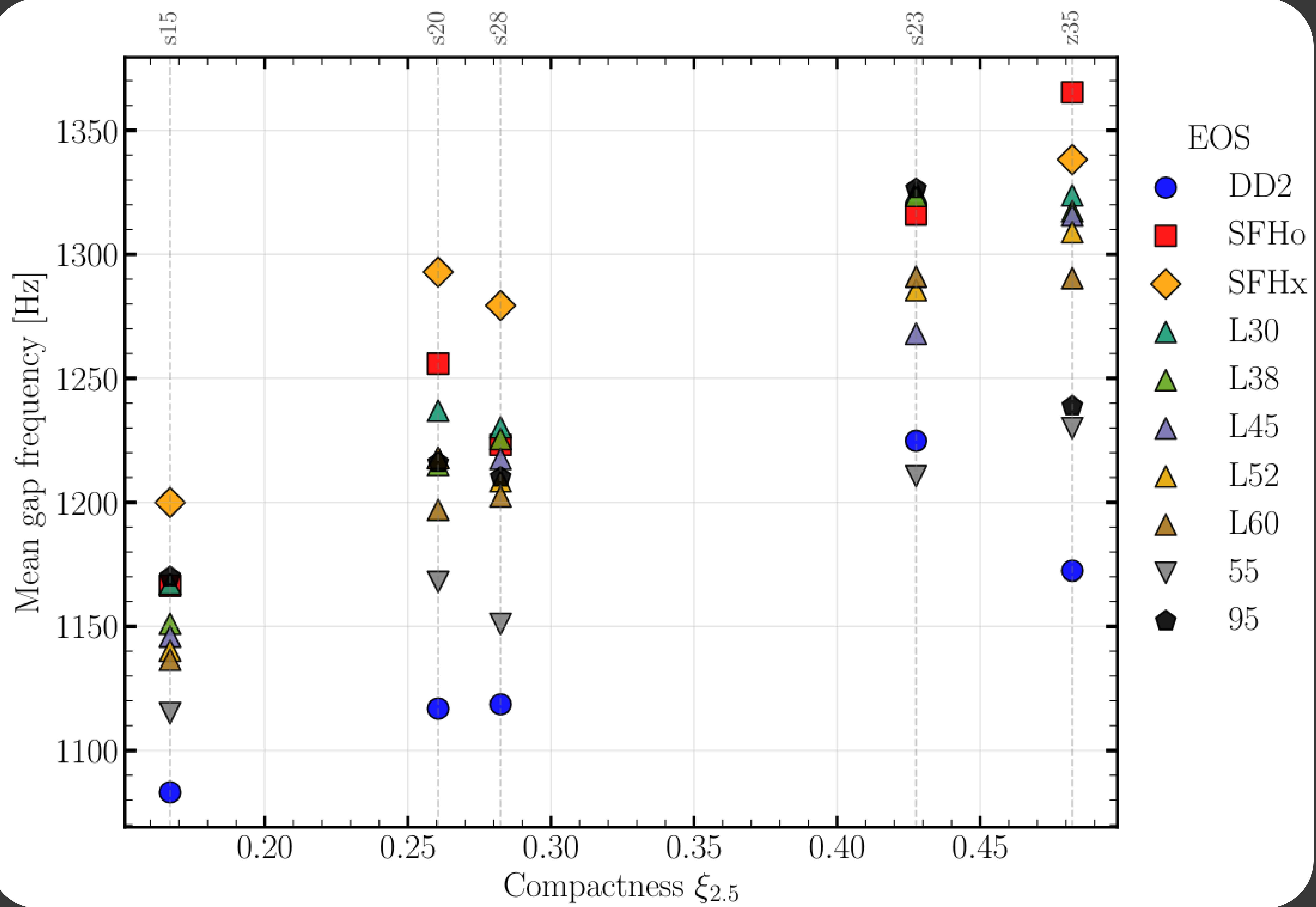
Correlation with Physics





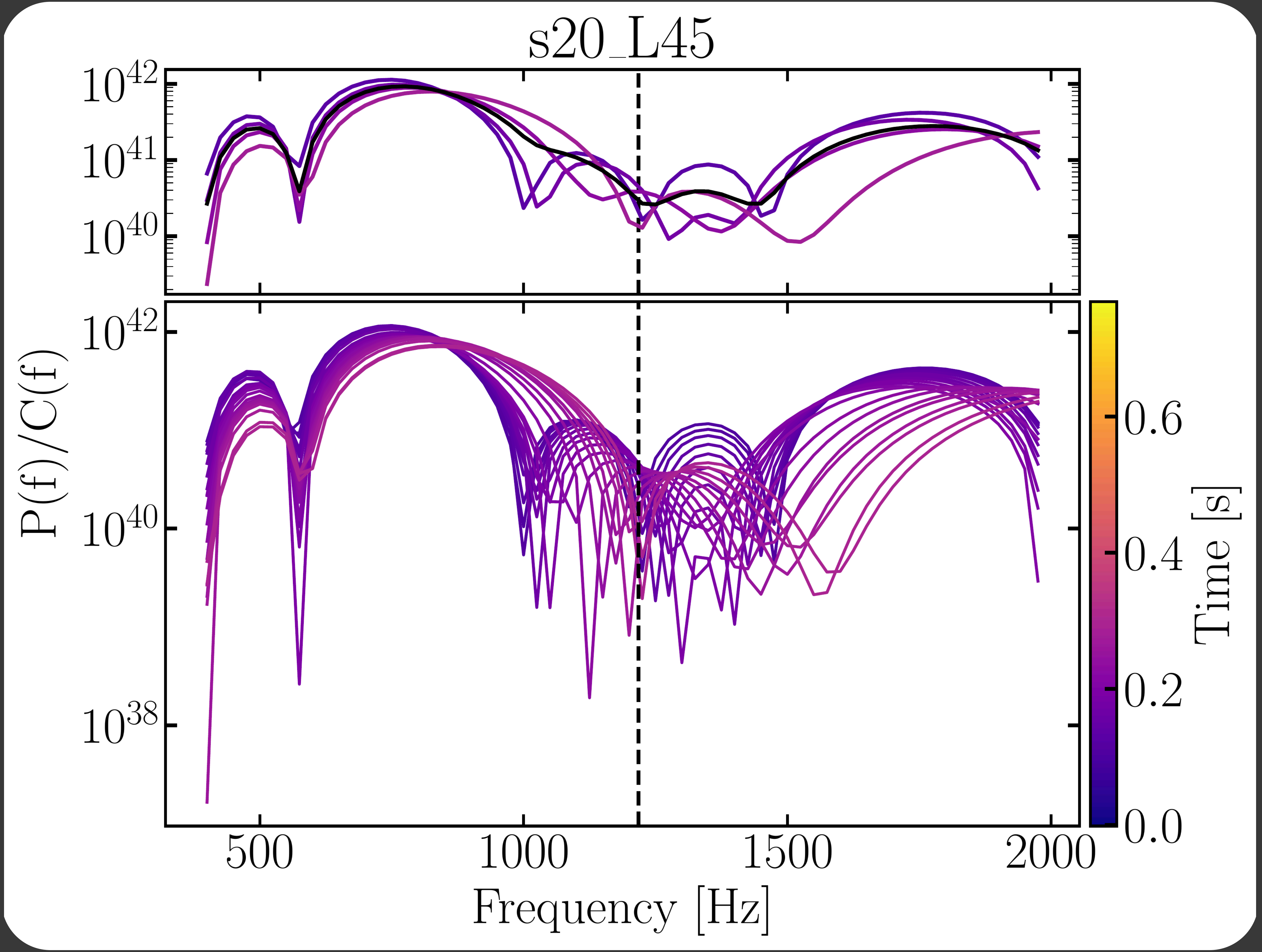
Equation of State

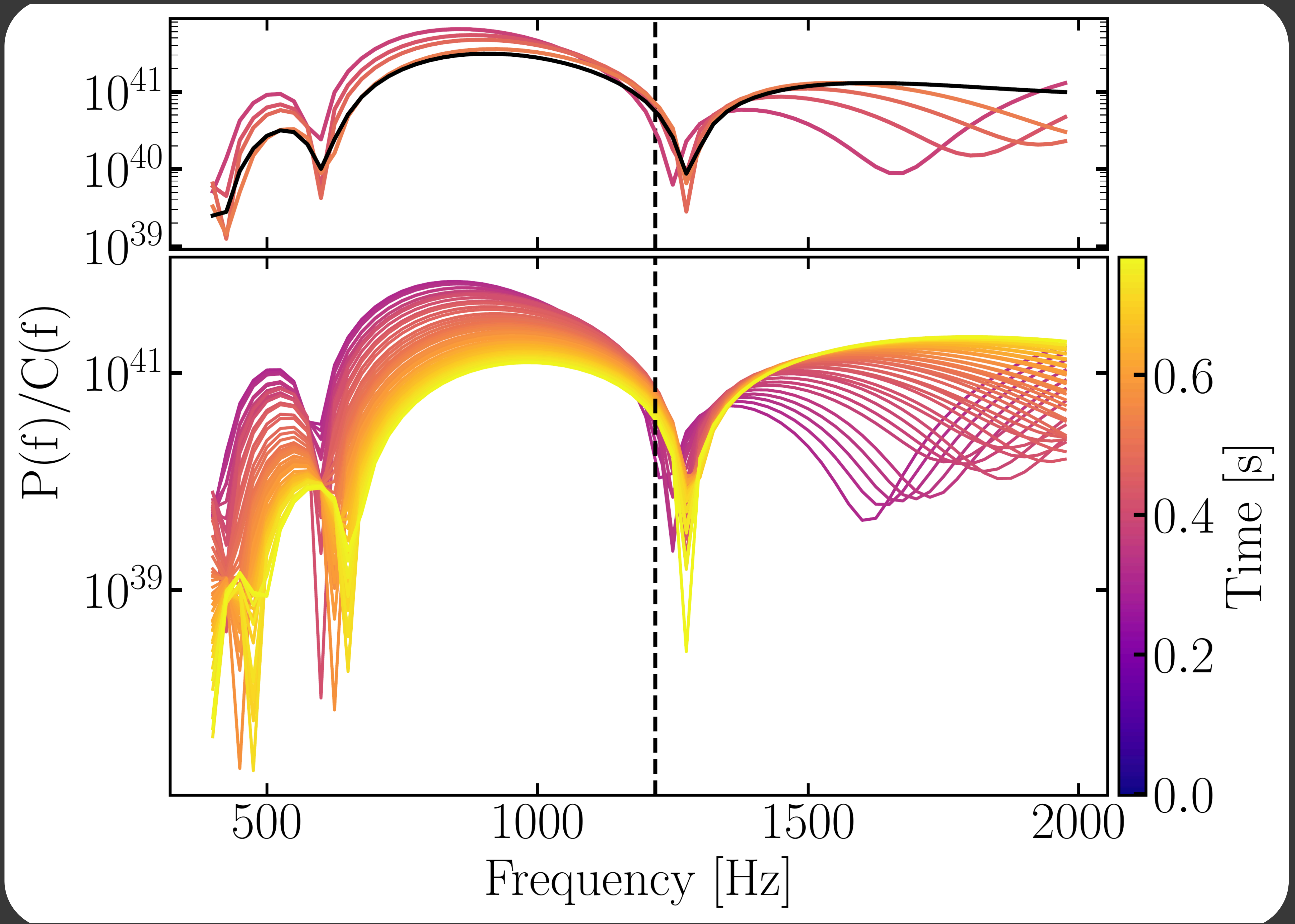
- Weak trends
- Progenitor influence



Mechanism

Zha et al. (2024)

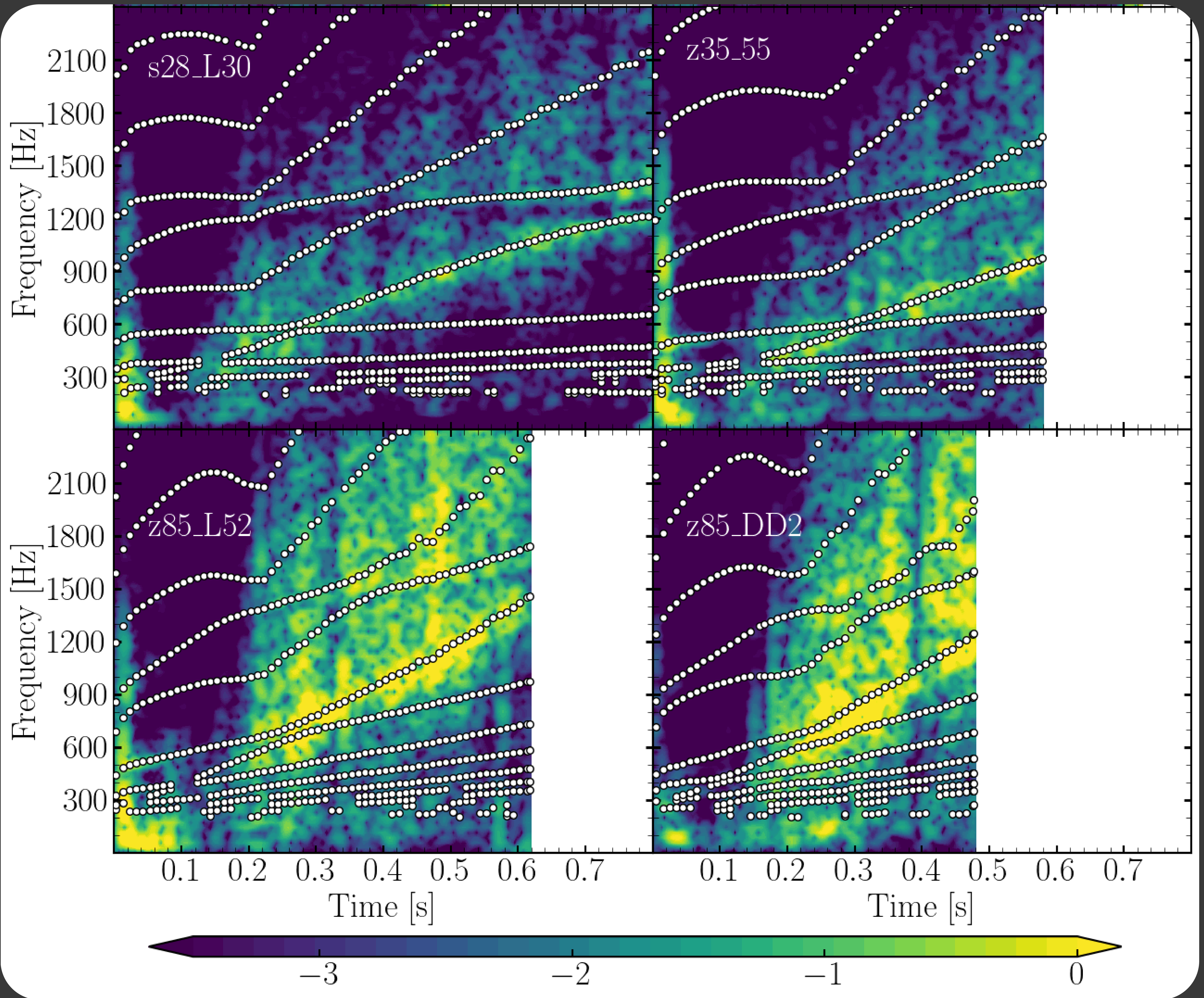




- Get zero when you integrate over the whole PNS.
- Works well?

Modes

- Avoided crossing at the gap frequency
- Weak coupling between modes



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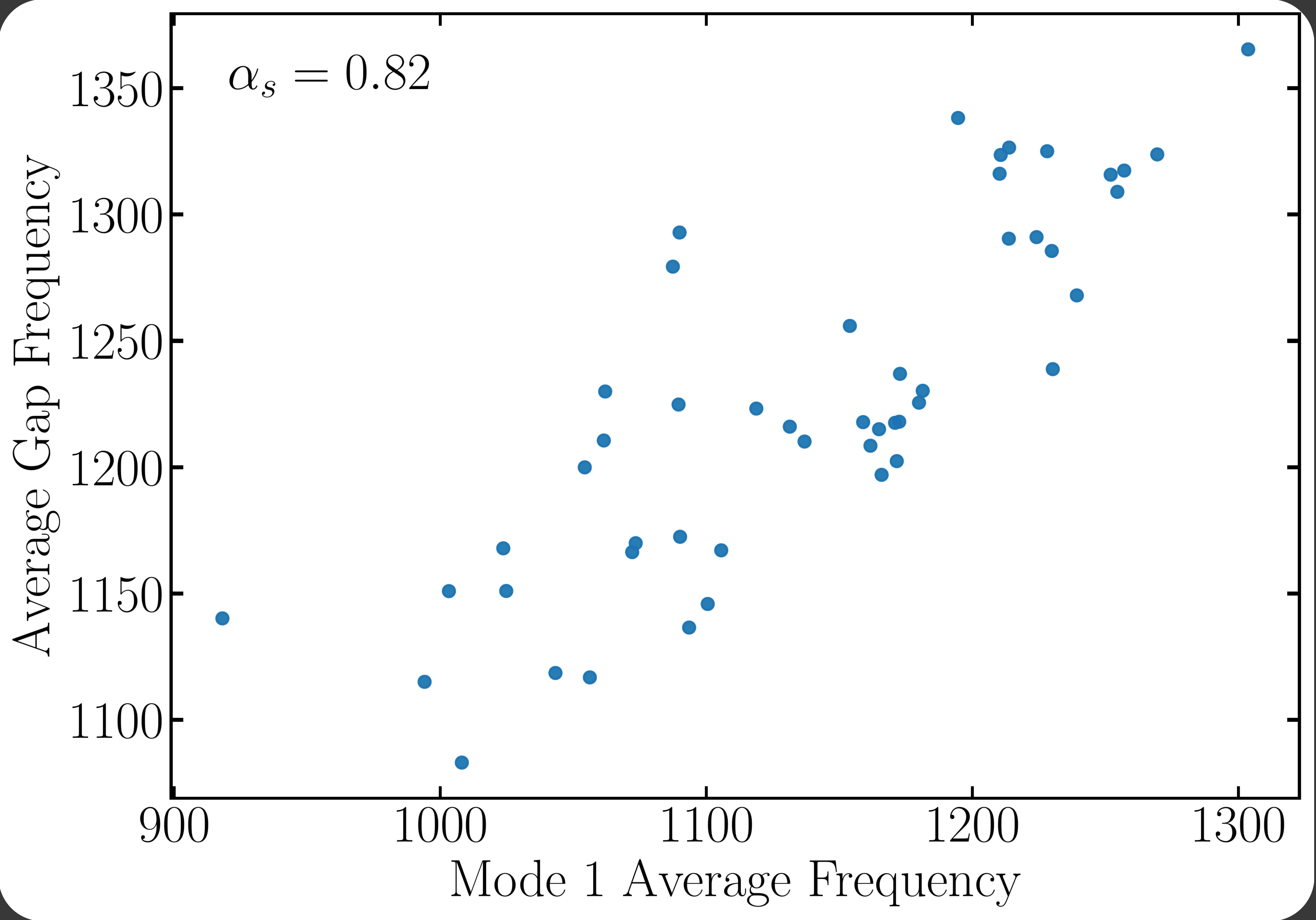
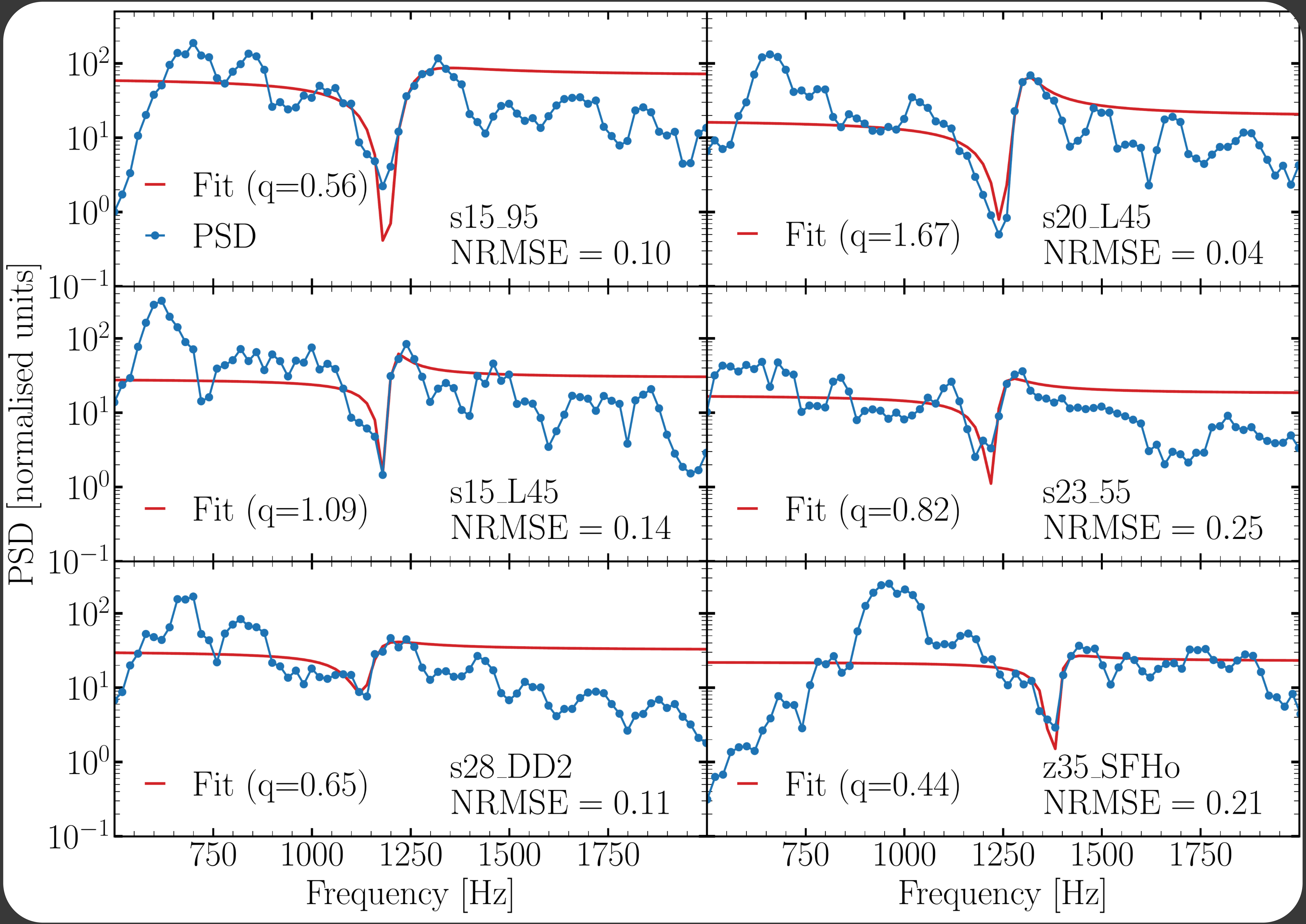


Fano resonance

- Asymmetric line-shape
- Fits, but not clear evidence
- Needs a stable mode and a continuum background



Summary

- Clearly connected to the inner parts of the PNS
- Still unclear where it comes from
- EOS/PNS information