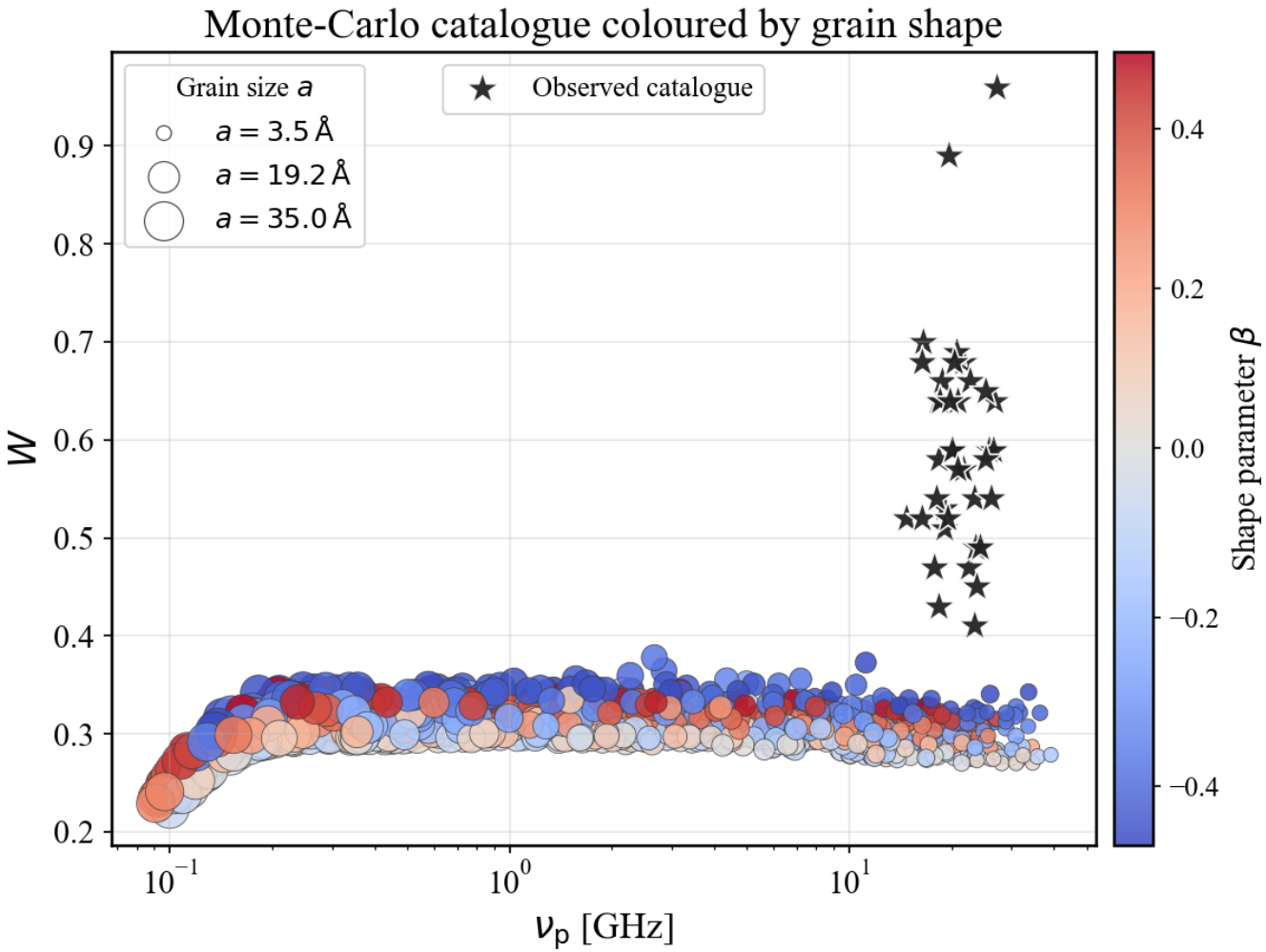
On the AME feature analysis

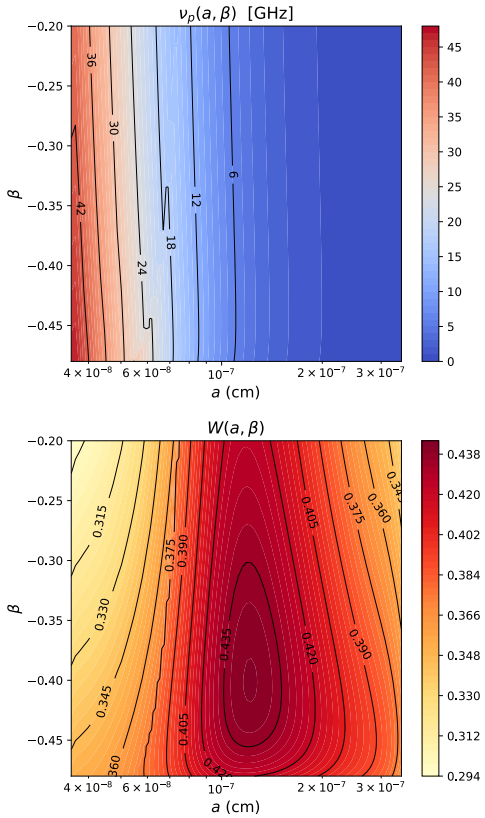
Paper plan

1. Introduction
   Include the observed AME feature catalogue from Roke's paper.
2. SED Variations with Environment and Grain
   Case Study (SEDs variations)
   Global Sensitivity Analysis (Monte Carlo samples)
3. Broadening effect from environment and grain ensembles
   Case Study (general distribution; model distribution; Monte Carlo samples vs Observation Catalogue)
   Ensemble over the key parameters
4. Moment expansion and emulators;
   Emulate SED features; mapping between two moments of size distribution and the AME feature.
   Observation catalogue fitting/inference
5. Conclusions

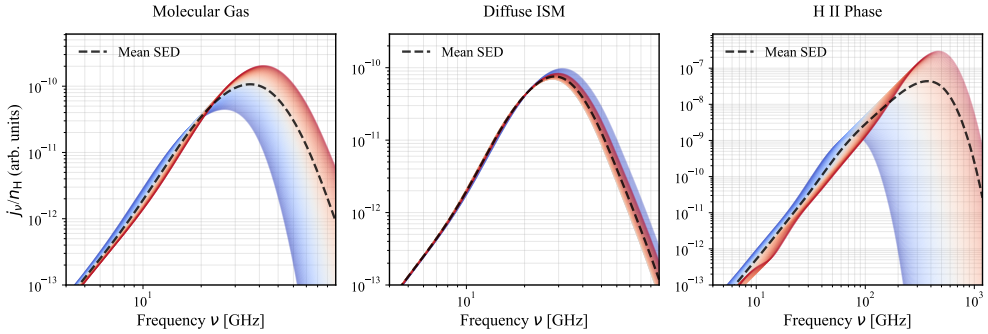
Single-size grains, single environment



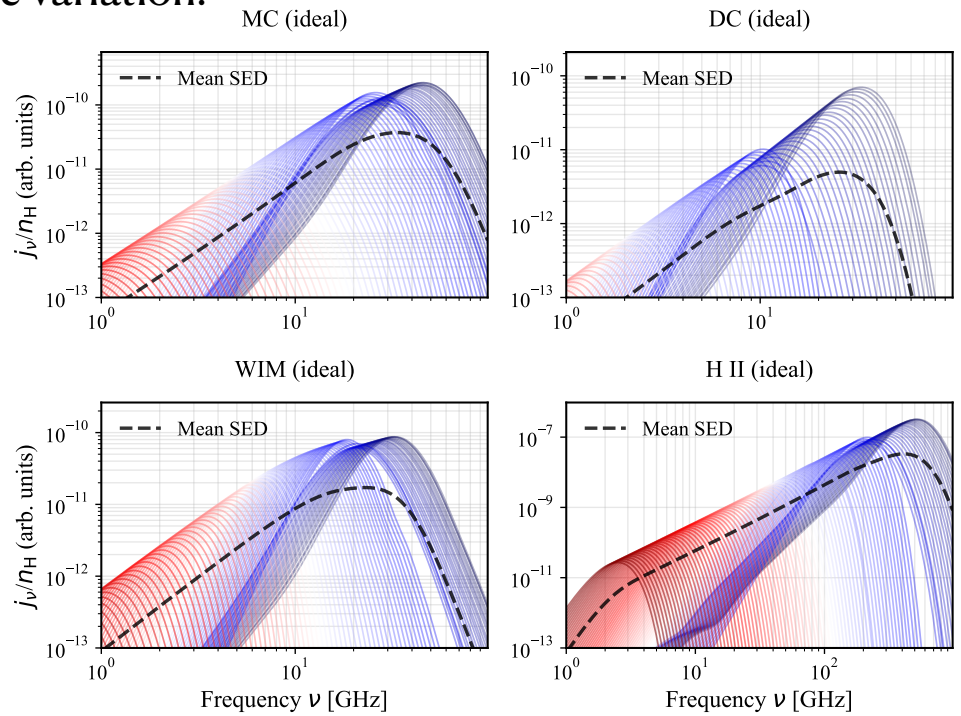
Single-size grains, single environment (case study)



Environment variation:



Grain size variation:



Single-size grains, single environment

Global Sensitivity Analysis (GSA)

(a) Target: peak frequency, ν_{peak}.

Param	MI	dCor	PermMean	PermStd	ARD_LS	S_1	$S_{1,\mathrm{conf}}$	S_T	$S_{T,\mathrm{conf}}$
a	0.4880	0.7163	1.2724	0.0893	3.6044	0.8192	0.0775	0.8849	0.0725
xC	0.1520	0.3806	0.6606	0.0724	1.4115	0.0624	0.0254	0.0947	0.0192
beta	0.0331	0.1530	0.0784	0.0096	10.4875	0.0426	0.0193	0.0579	0.0075
nh	0.0236	0.1494	0.0646	0.0114	6.0126	0.0189	0.0147	0.0298	0.0055
T	0.0000	0.0737	0.0013	0.0005	82.4455	0.0026	0.0047	0.0029	0.0003
Chi	0.0000	0.0366	0.0007	0.0006	9.6513	0.0003	0.0031	0.0014	0.0002
y	0.0000	0.0482	-0.0003	0.0007	100.0000	0.0001	0.0005	0.0000	0.0000

AggRank (top): a (1.2), xC (1.8); bottom: y (6.6).

(b) Target: width.

Param	MI	dCor	PermMean	PermStd	ARD_LS	S_1	$S_{1,\mathrm{conf}}$	S_T	$S_{T,\mathrm{conf}}$
xC	0.3672	0.6410	0.8826	0.0651	1.3734	0.2658	0.0472	0.3073	0.0387
a	0.3421	0.6279	0.6882	0.0594	2.9684	0.5510	0.0574	0.6115	0.0538
beta	0.2058	0.1994	0.1265	0.0107	2.9380	0.0339	0.0169	0.0445	0.0046
nh	0.0000	0.1824	0.0411	0.0055	3.8350	0.0350	0.0177	0.0530	0.0068
T	0.0013	0.1200	0.0225	0.0032	10.0802	0.0462	0.0184	0.0501	0.0051
Chi	0.0000	0.0576	0.0008	0.0008	6.8574	-0.0005	0.0080	0.0094	0.0015
y	0.0000	0.0449	-0.0006	0.0005	100.0000	0.0001	0.0007	0.0001	0.0000

AggRank (top): xC (1.2), a (2.0); bottom: y (6.8).

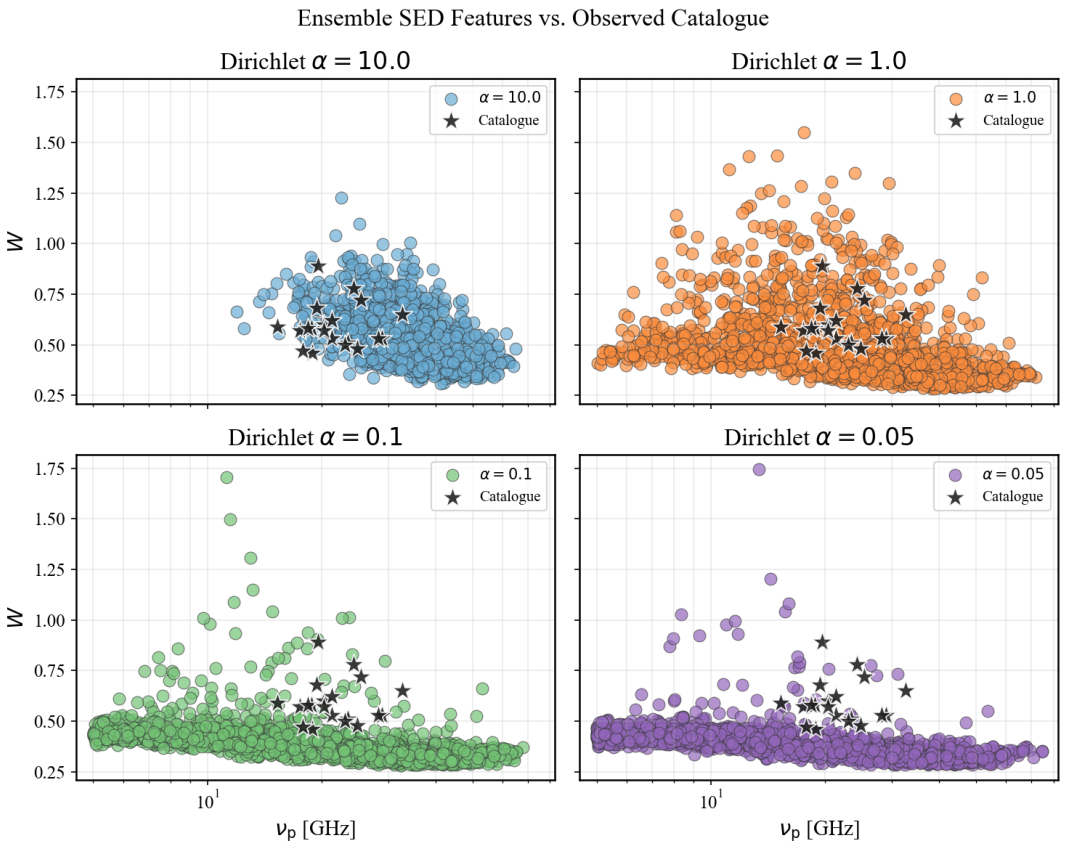
(MC as an example)

Key parameters:

- Molecule Cloud: {a, beta, x_C}
- Dark Cloud: {a, beta, x_C}
- H II Region: {a, beta, n_H}

Ensemble effect (General Distribution)

We consider the ensemble over the key parameters.



(MC as an example)

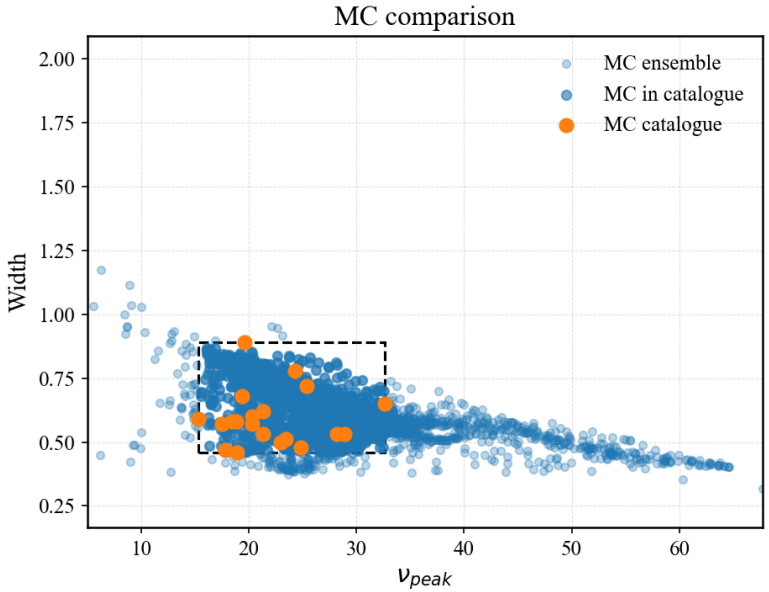
- First, we consider a Monte Carlo Dirichlet ensembles
- Here, 'alpha' represents how sparse or uniform the distribution is.

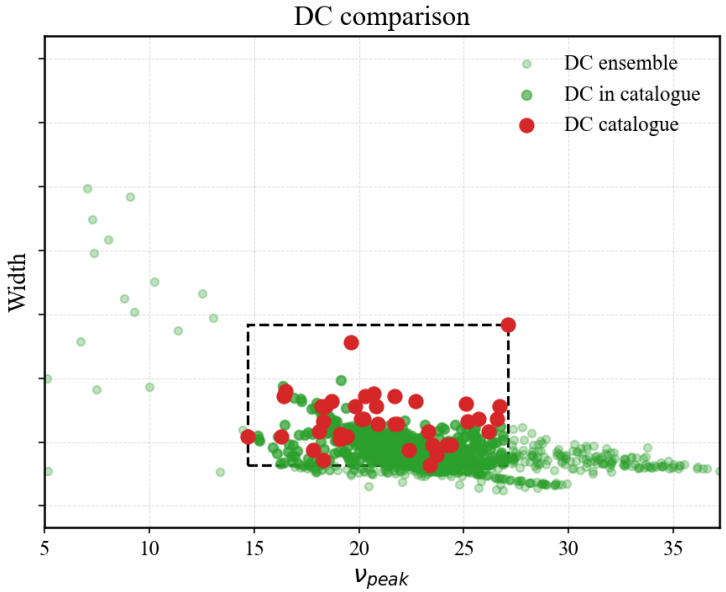
Ensemble effect (Model Distribution)

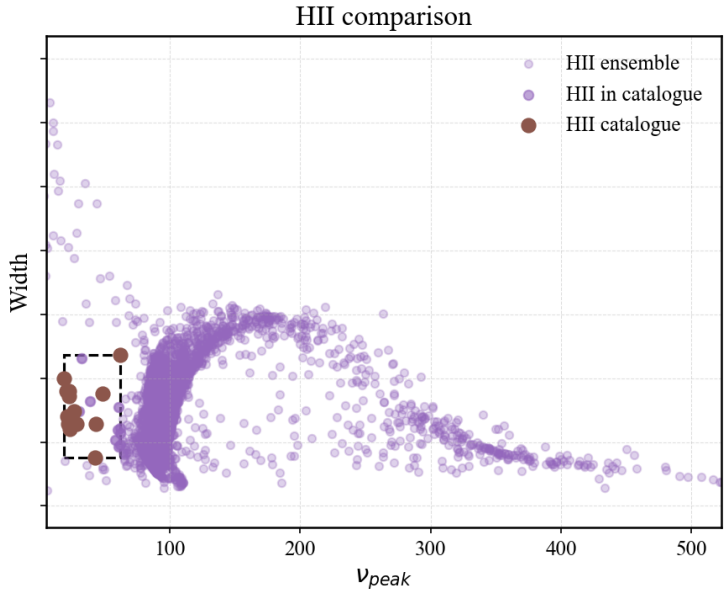
Multiplicative form:

log_normal(a) × log_normal(beta) × log_normal(environment)
Monte Carlo the distribution parameters.

- We can see MC observation catalogue is well in the regime.
- DC is partially out of the regime..
- The model is too general for H II.

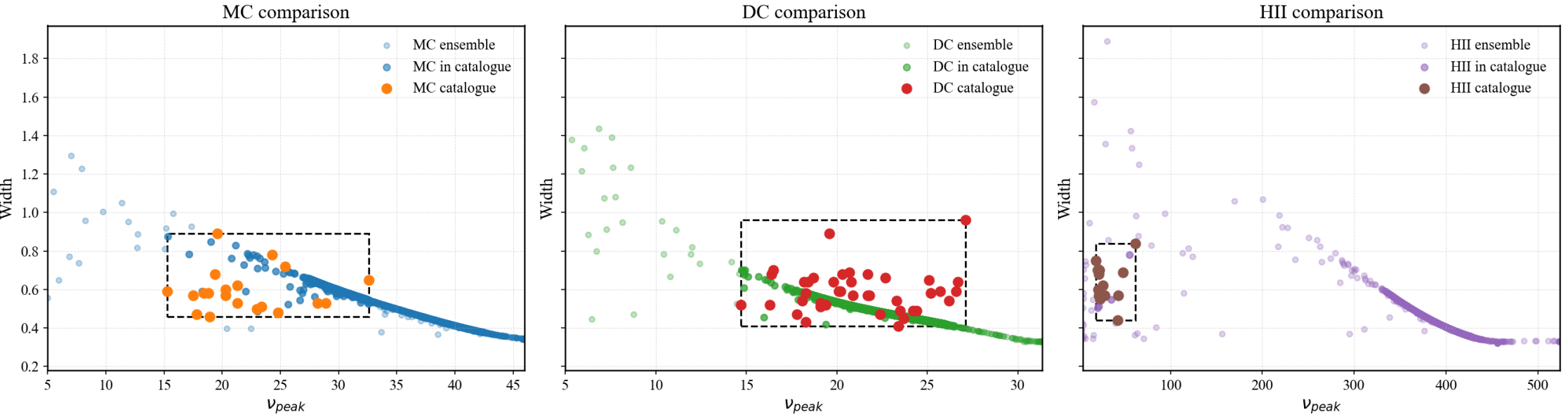






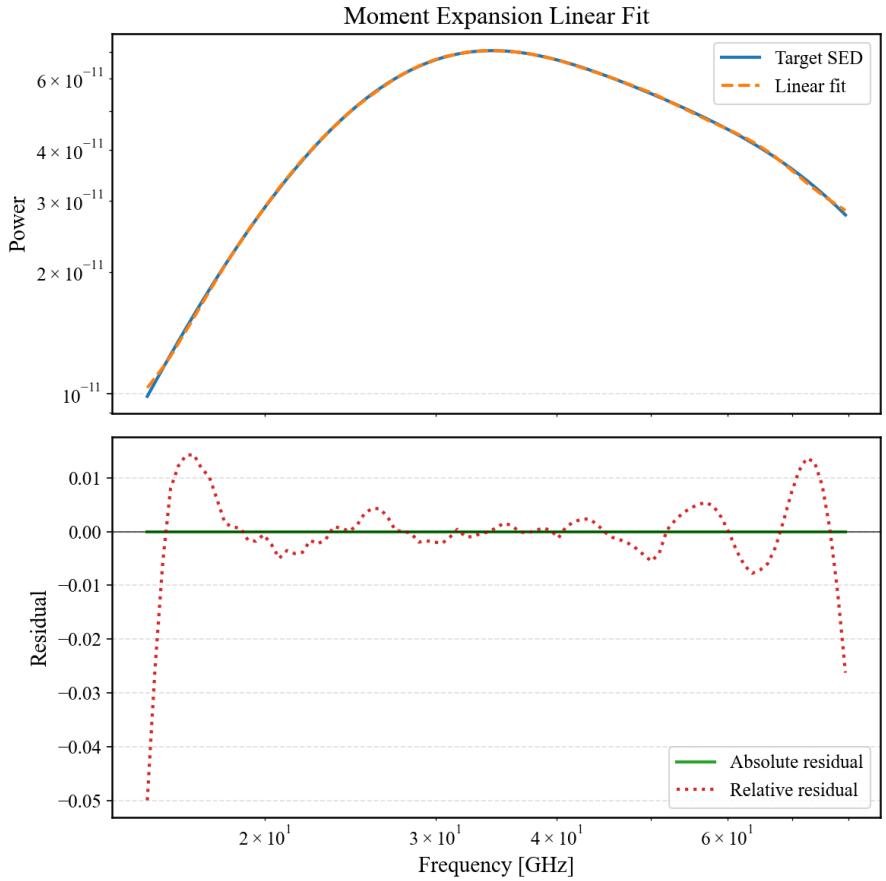
Ensemble effect (Only grain size ensemble)

If we fix the “beta” and “x_C” distribution, and only consider the distribution over “a”.

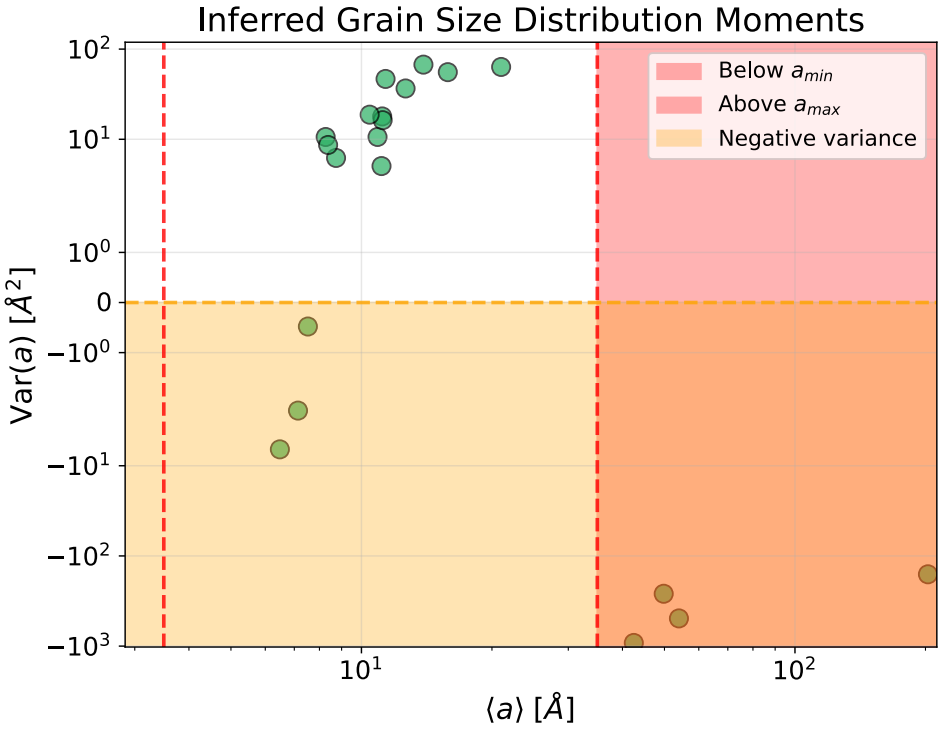


(MC as an example)

SED fitting: Moment Expansion



Emulation: Moment to SED features



(Three key parameters; second order; fixed pivot)