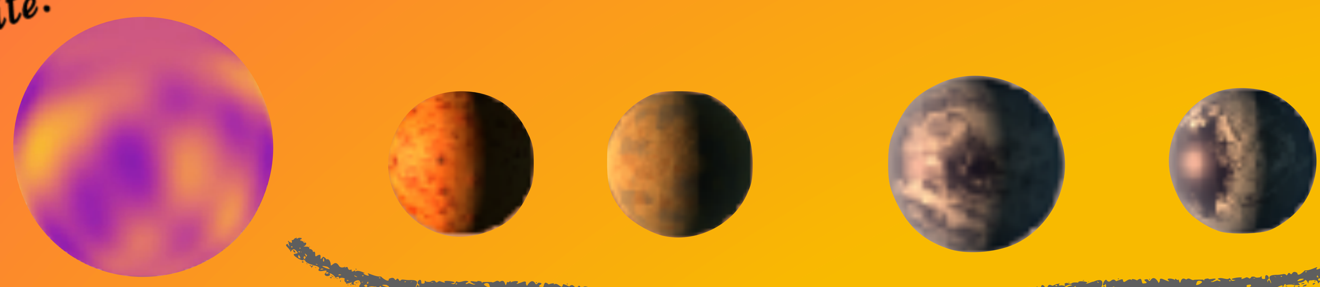
how planets help us understand stars?

a hierarchical model for starspots

this is me, **Sabina Sagynbayeva**

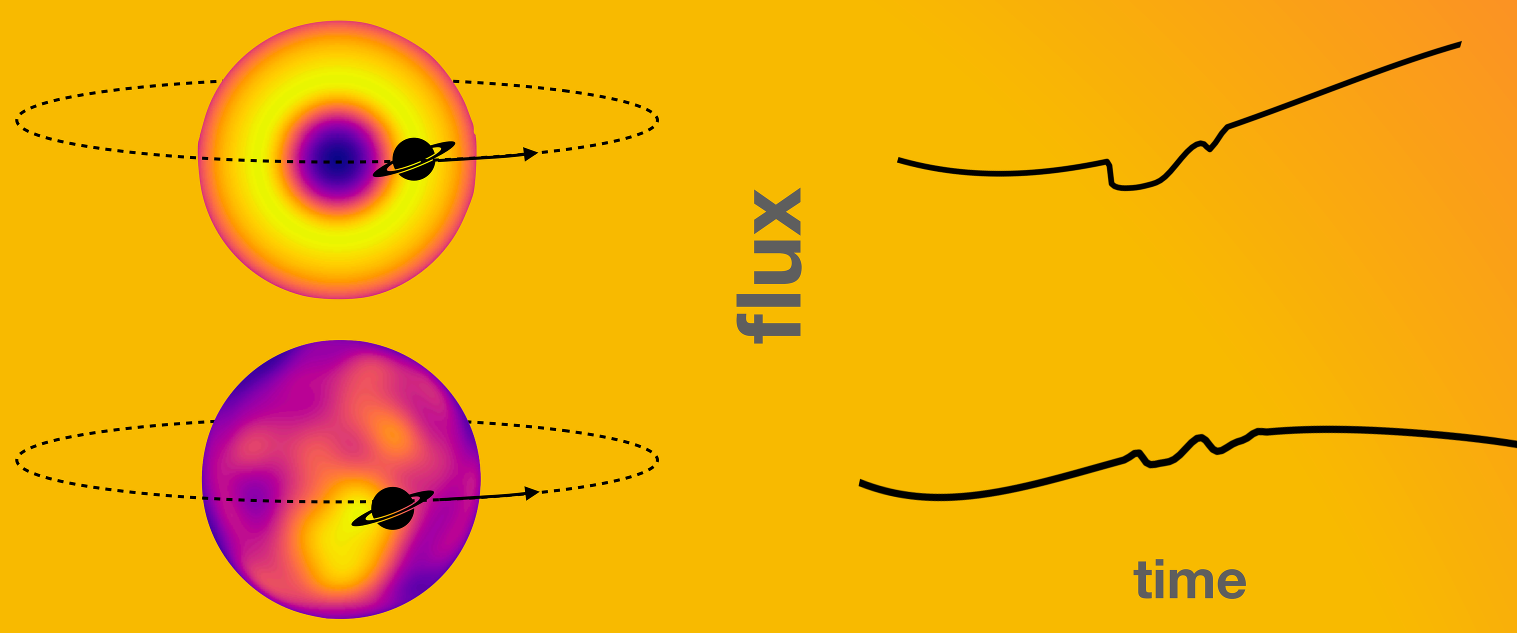
the work is in collaboration with Will M. Farr and Rodrigo Luger

my website!



you want to detect the atmospheres of these?
but **these** have too many starspots?

in-transit light curves encode information about starspots…
… and hence stellar magnetic fields & stellar evolution



I have a model for you that will help understand the stellar surface activity using planetary transits!

model description:

in our model, we want to get P(PARAMS | DATA)

mean spot size
mean active latitude
stellar inclination
planetary radius, etc

but we have P(DATA | PARAMS, NUISANCES)

mean spot size
mean active latitude
stellar inclination
planetary radius, etc

size of spot #13 on star #47
longitude of spot #31 on star #12
contrast of spot #2 on star #55
latitude of spot #12 on star #18

the in-transit information helps us get the parameters of starspots solely from photometric data!

therefore, we marginalize over the nuisances and get

P(PARAMS, NUISANCES | DATA) ~ P(DATA | PARAMS, NUISANCES) P(PARAMS, NUISANCES)

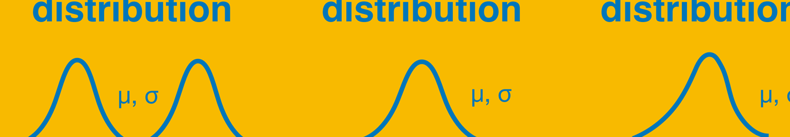
joint posterior — likelihood — prior

we also approximate our likelihood as a gaussian

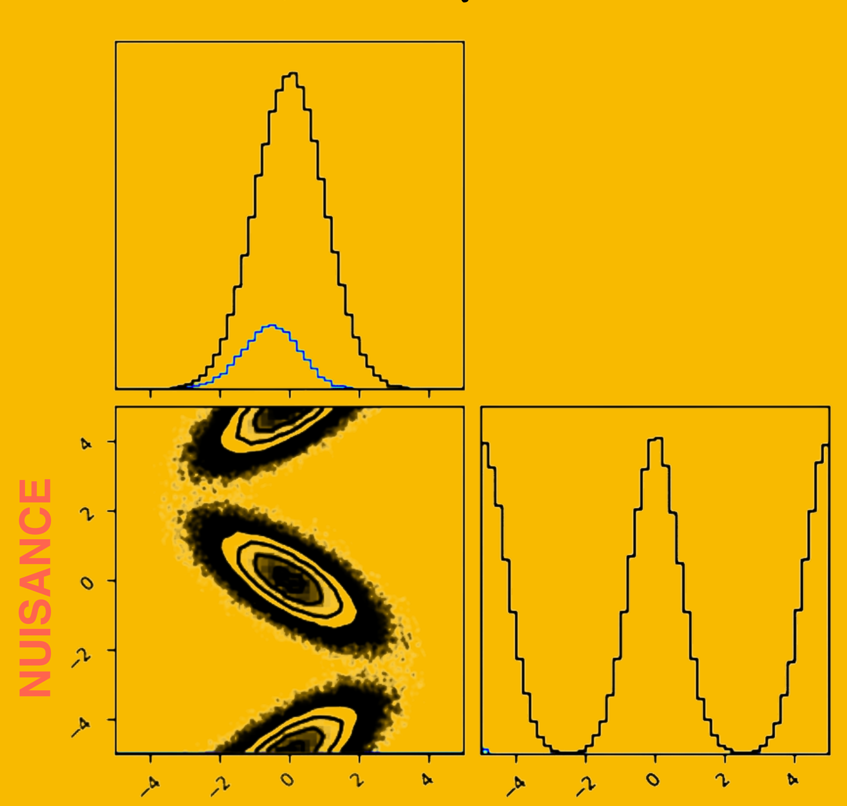
$$\mathcal{N}(\text{DATA} - \text{MODEL}; \mu, \Sigma)$$

functions of things we might care about (or have prior knowledge about):

spot latitude distribution — spot size distribution — spot contrast distribution



mcmc

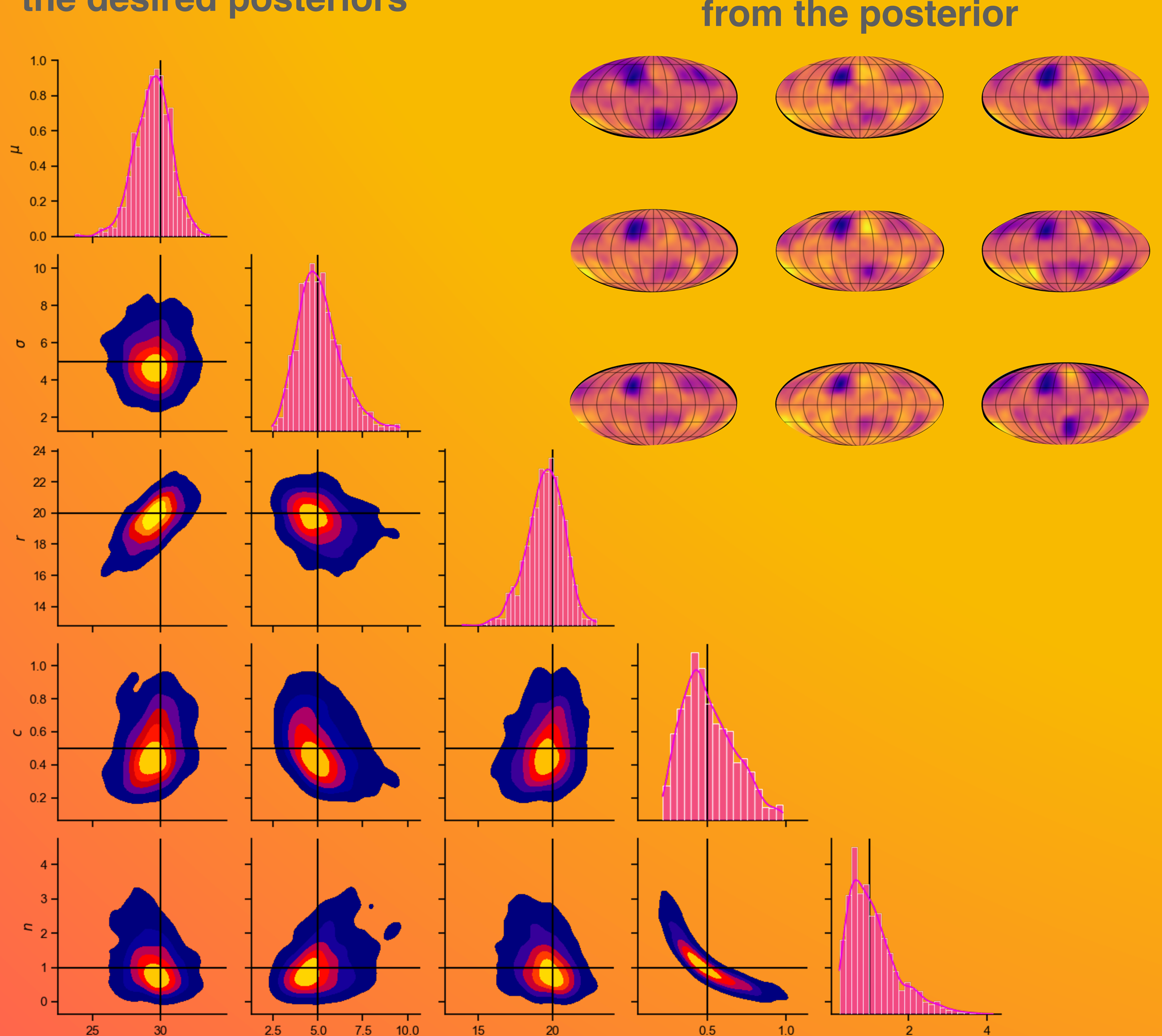


integrate

P(PARAMS | DATA)

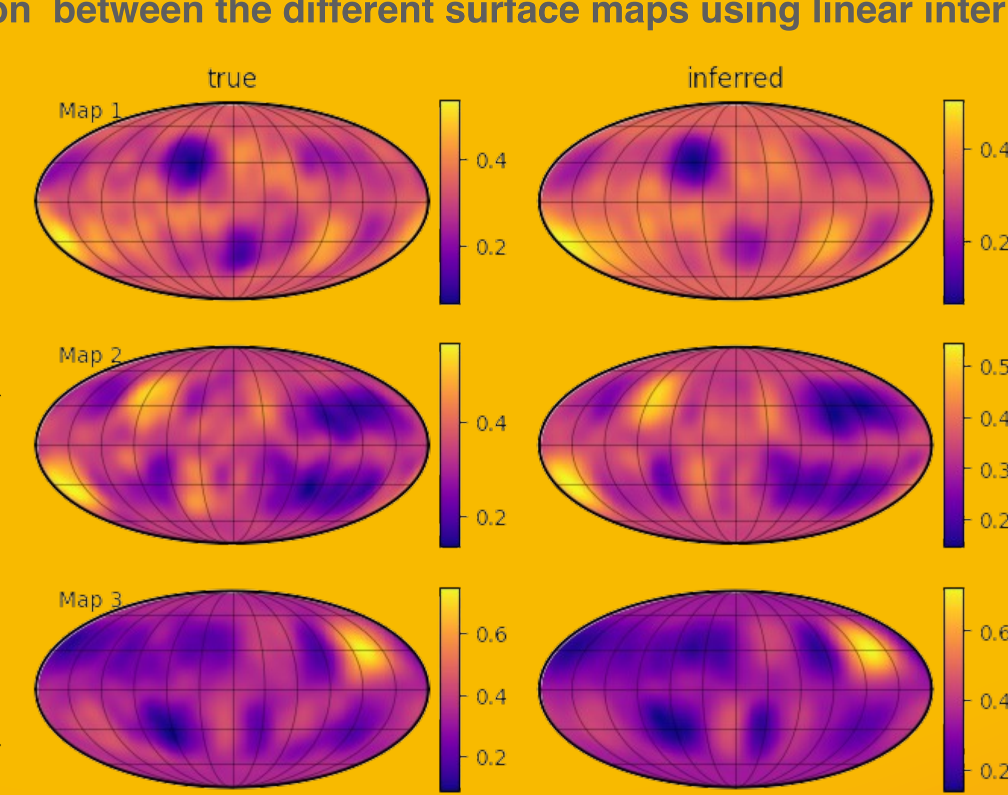
marginal posterior

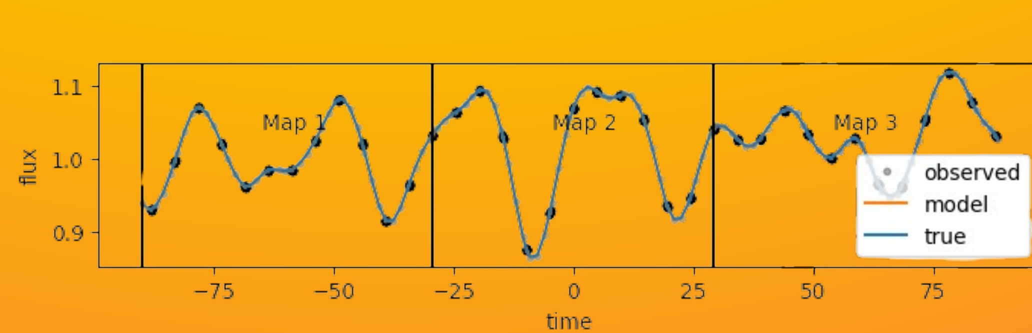
in the end, we will get the desired posteriors



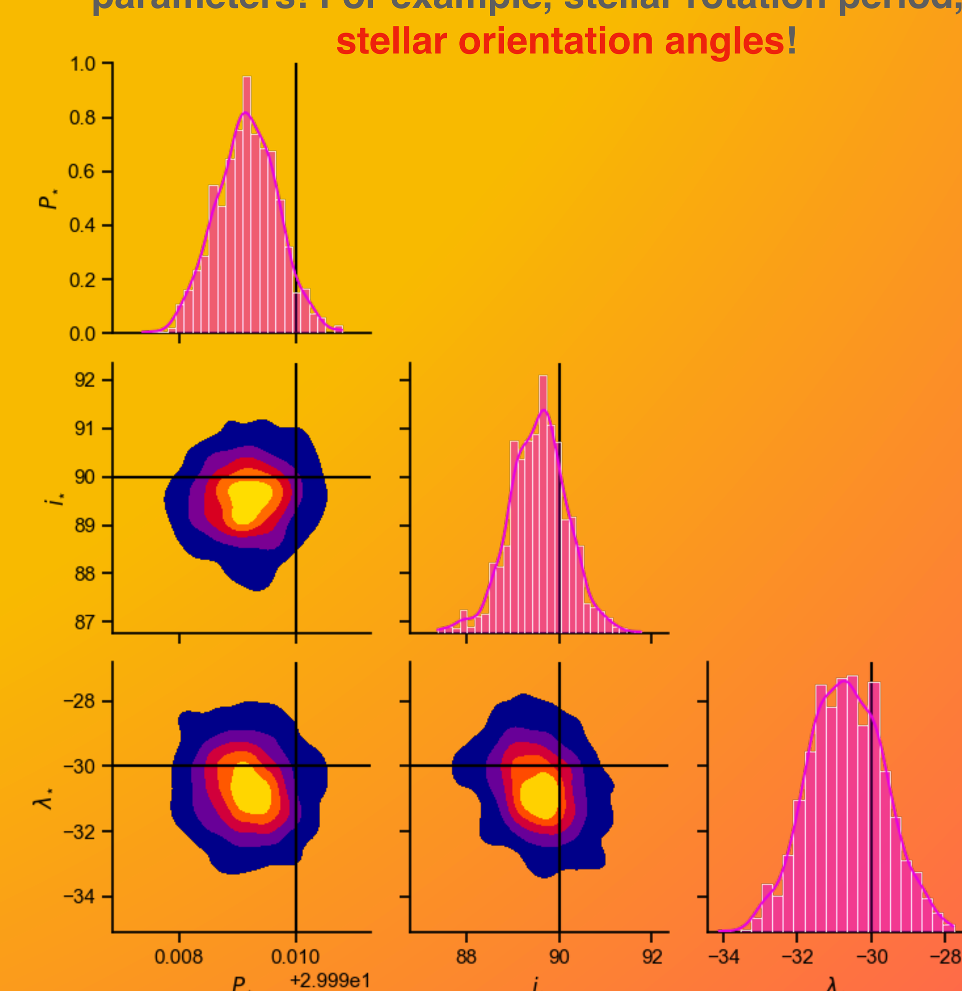
and samples of the surface map from the posterior

if the stellar surface map evolves at some timescale t, we assume the smooth transition between the different surface maps using linear interpolation

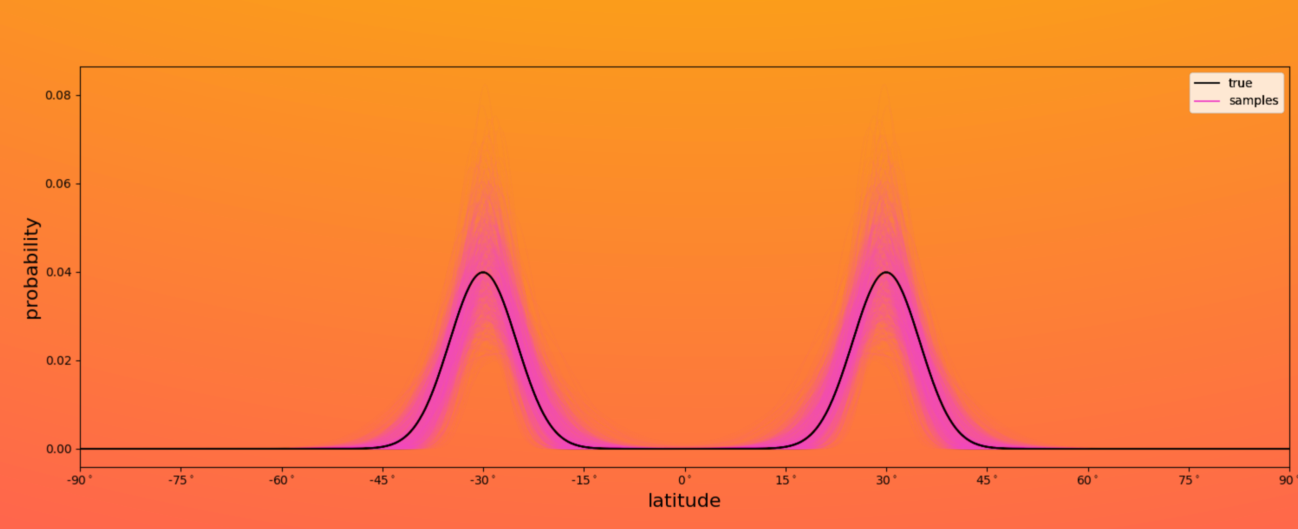




as a bonus, with our model, we can infer other physical parameters! For example, stellar rotation period, and **stellar orientation angles**!



and, of course, active regions of the star



stay tuned for more!

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