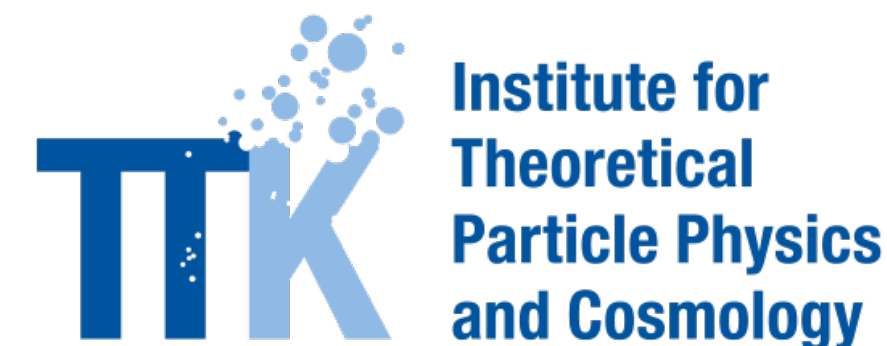


mw-atlas

Towards the three-dimensional shape of the Milky Way Galaxy in Gas and Dust

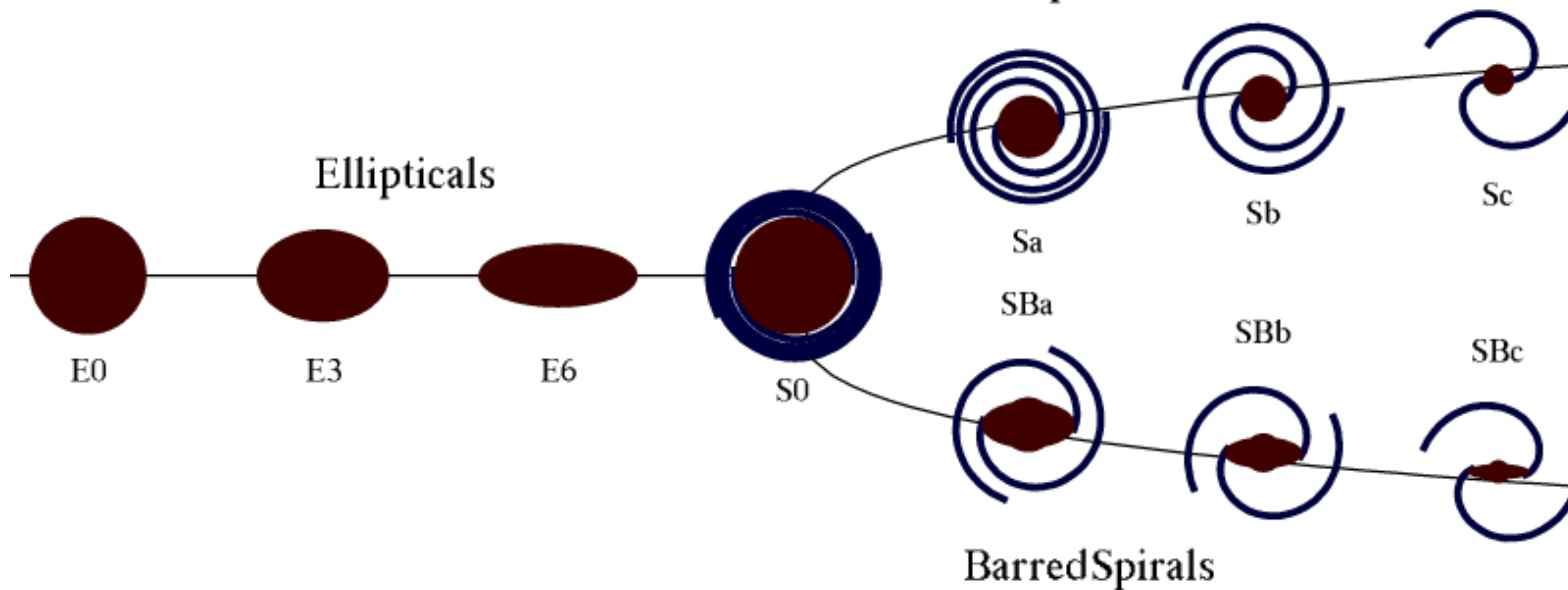
**Fabian Polnitzky
with**

**Laurin Söding and Philipp Mertsch
*RWTH Aachen University***



Morphology of Galaxies

Hubble Classification Scheme



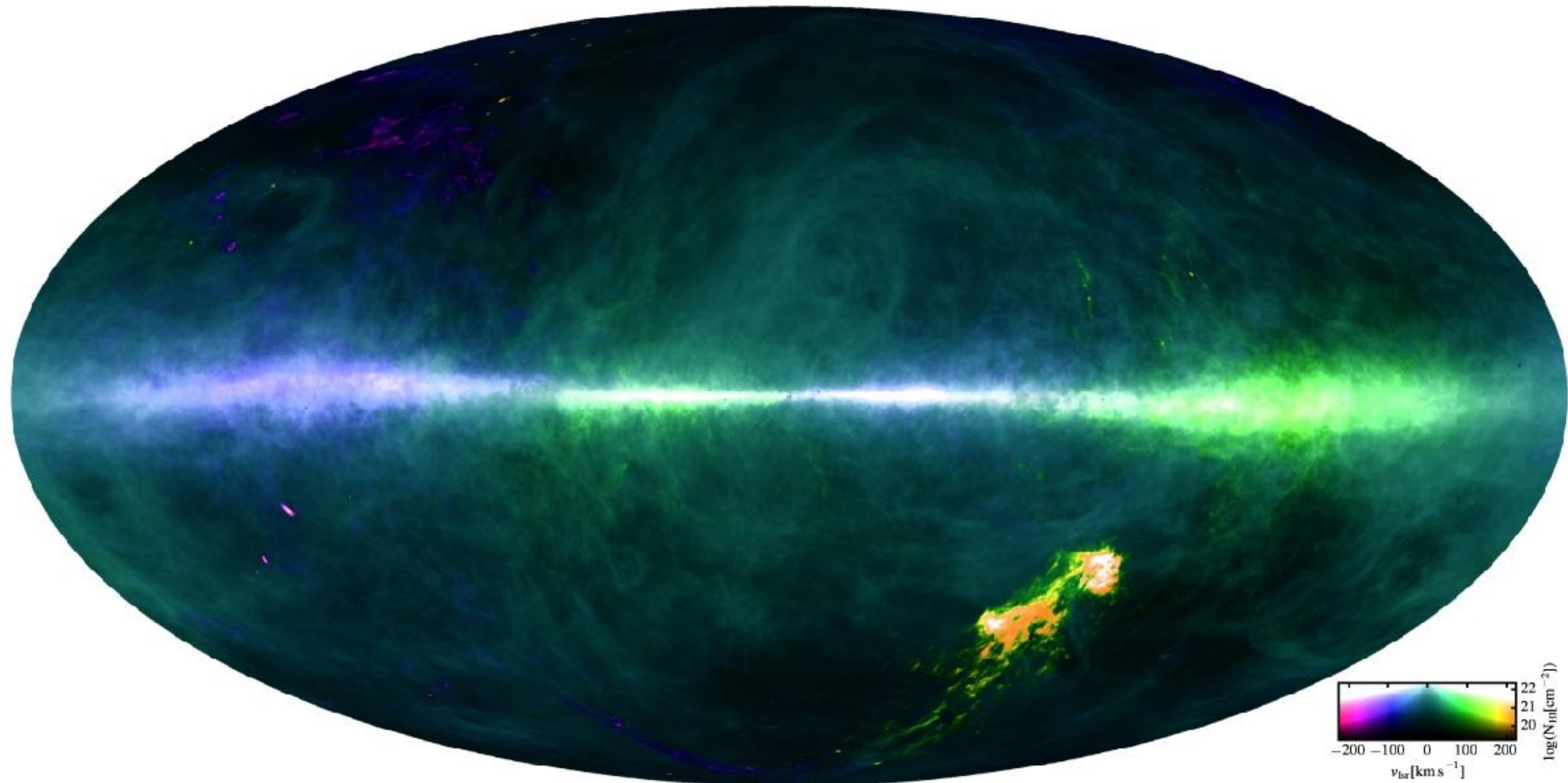
NGC 474



Messier 100

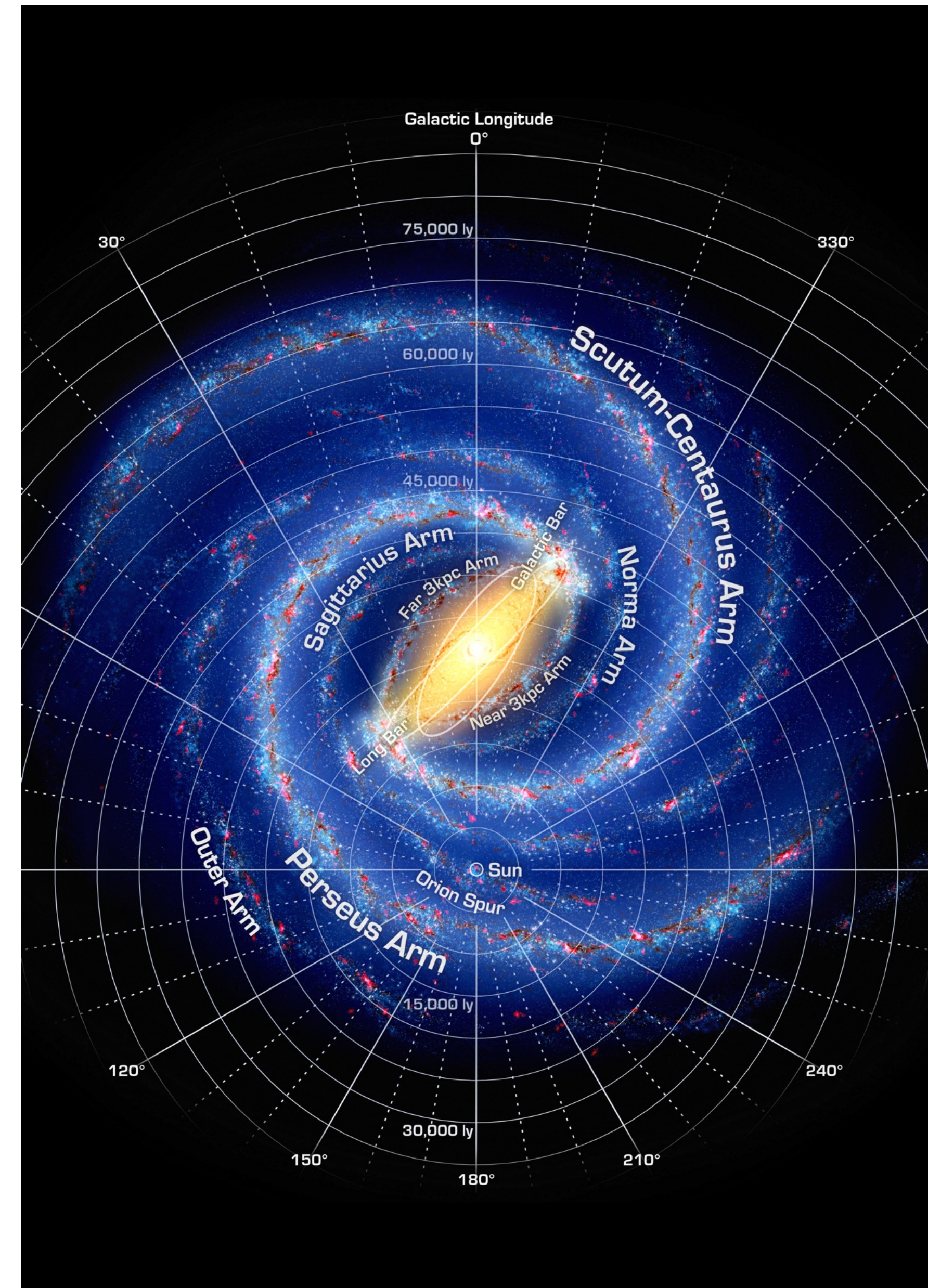


Milky Way in Neutral Hydrogen - HI4PI



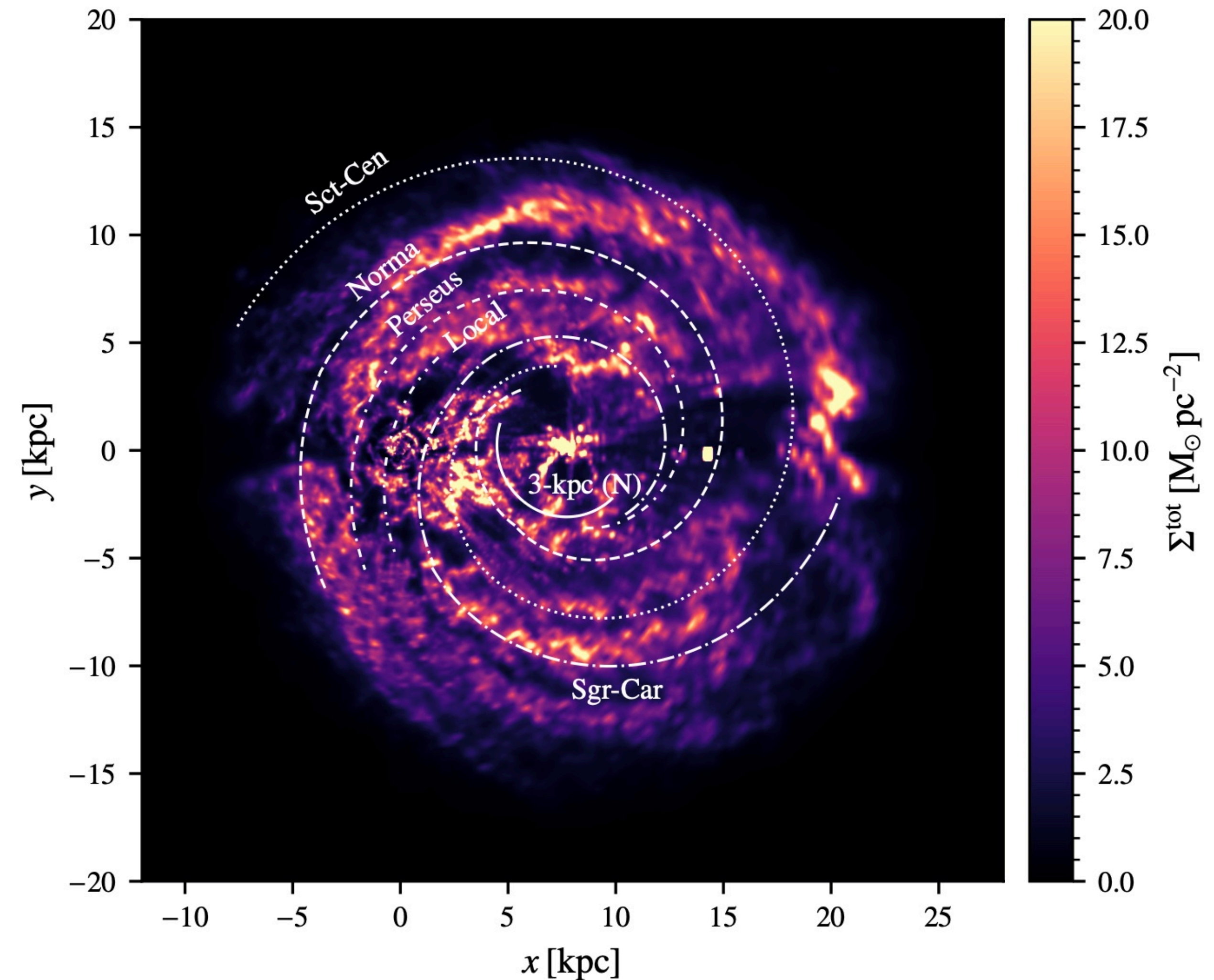
Structure of the Milky Way

- Exact shape is obscured
- Can combine pieces to a larger picture
- Similar to taking a full body picture of someone or taking a selfie of your entire body



Söding et al. 2024

- Three-dimensional map of the Milky Way Galaxy in atomic and molecular hydrogen
- Forward model: three-dimensional spatial density $\rightarrow$ two-dimensional observations
- Bayesian inference inverts model to give spatial density from HI4PI observations



Variational Inference

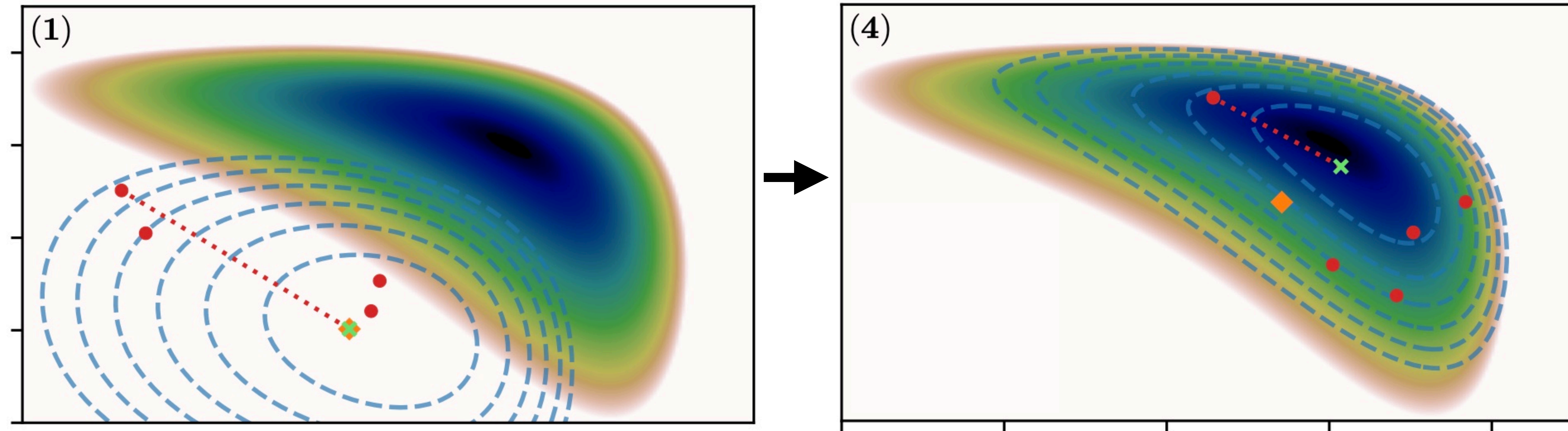
Start with Bayes' Rule

$$p(\text{Map} | \text{Model}, \text{Observ}) \propto p(\text{Observ} | \text{Map}, \text{Model}) p(\text{Map}, \text{Model})$$

Algorithm of Variational Inference

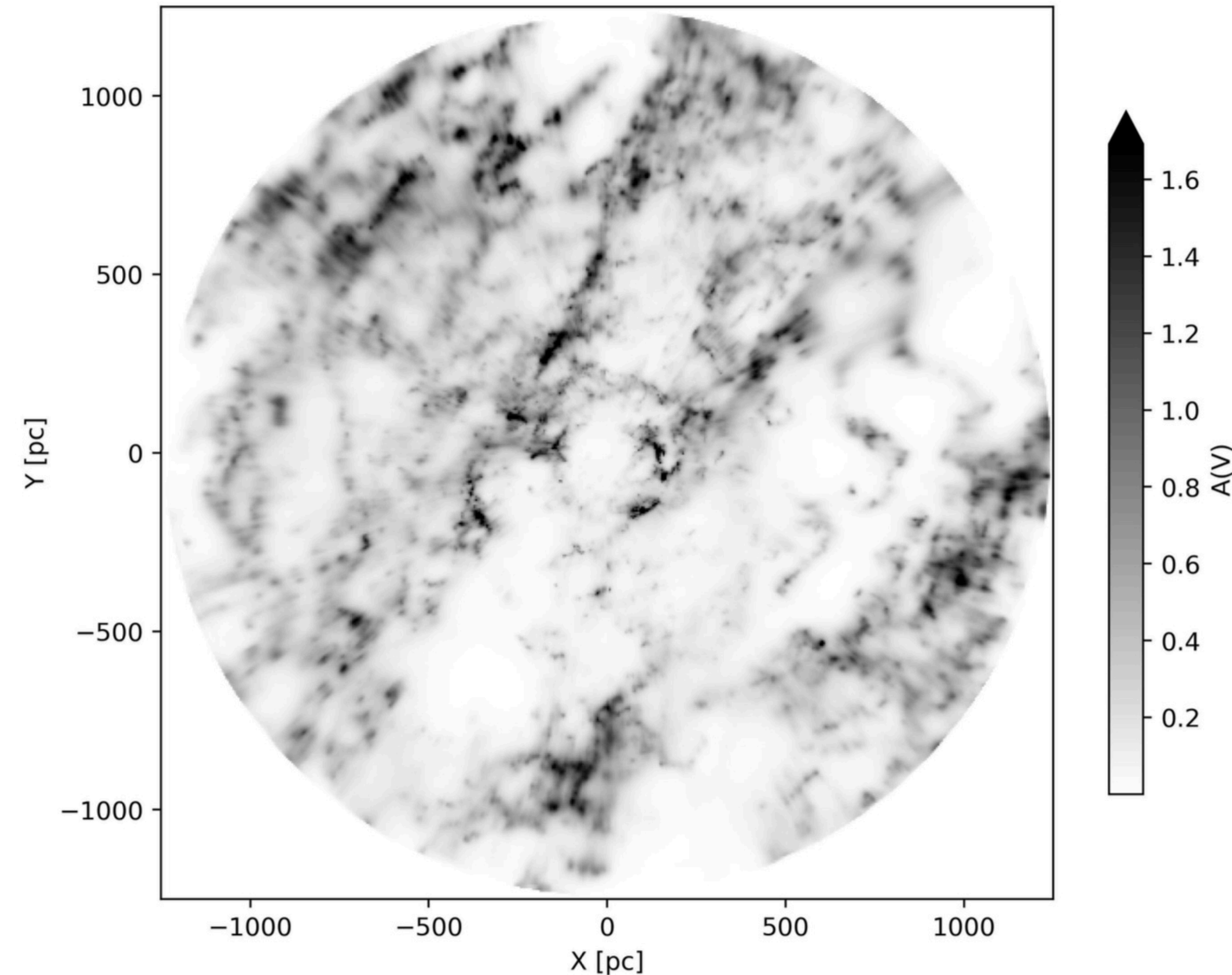
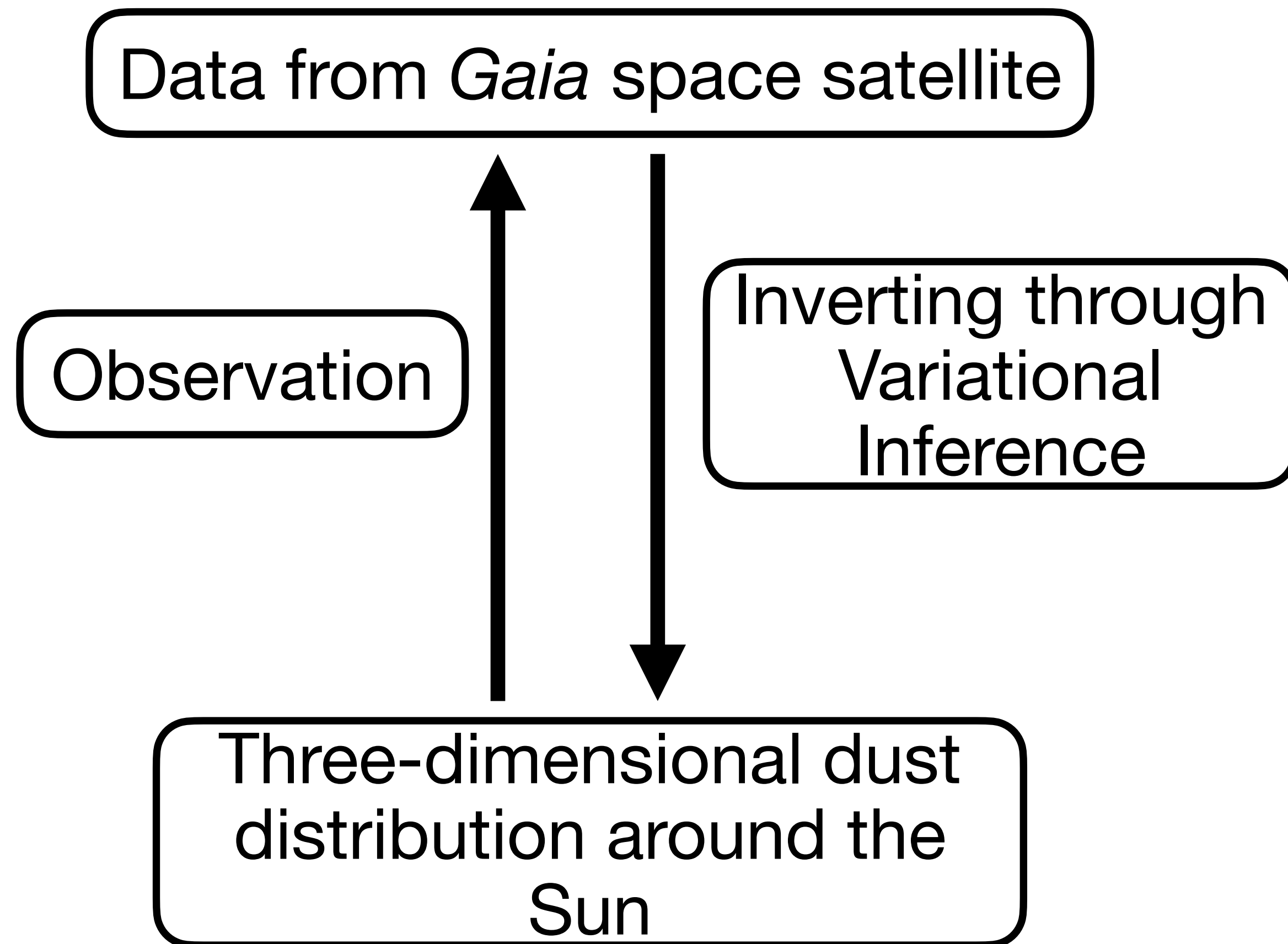
1. Approximate posterior of unknown shape with a guide distribution
2. Estimate difference of the two using Kullback-Leibler Divergence
3. Optimise the parameters of the guide distribution
4. Repeat 2. - 4.

Variational Inference



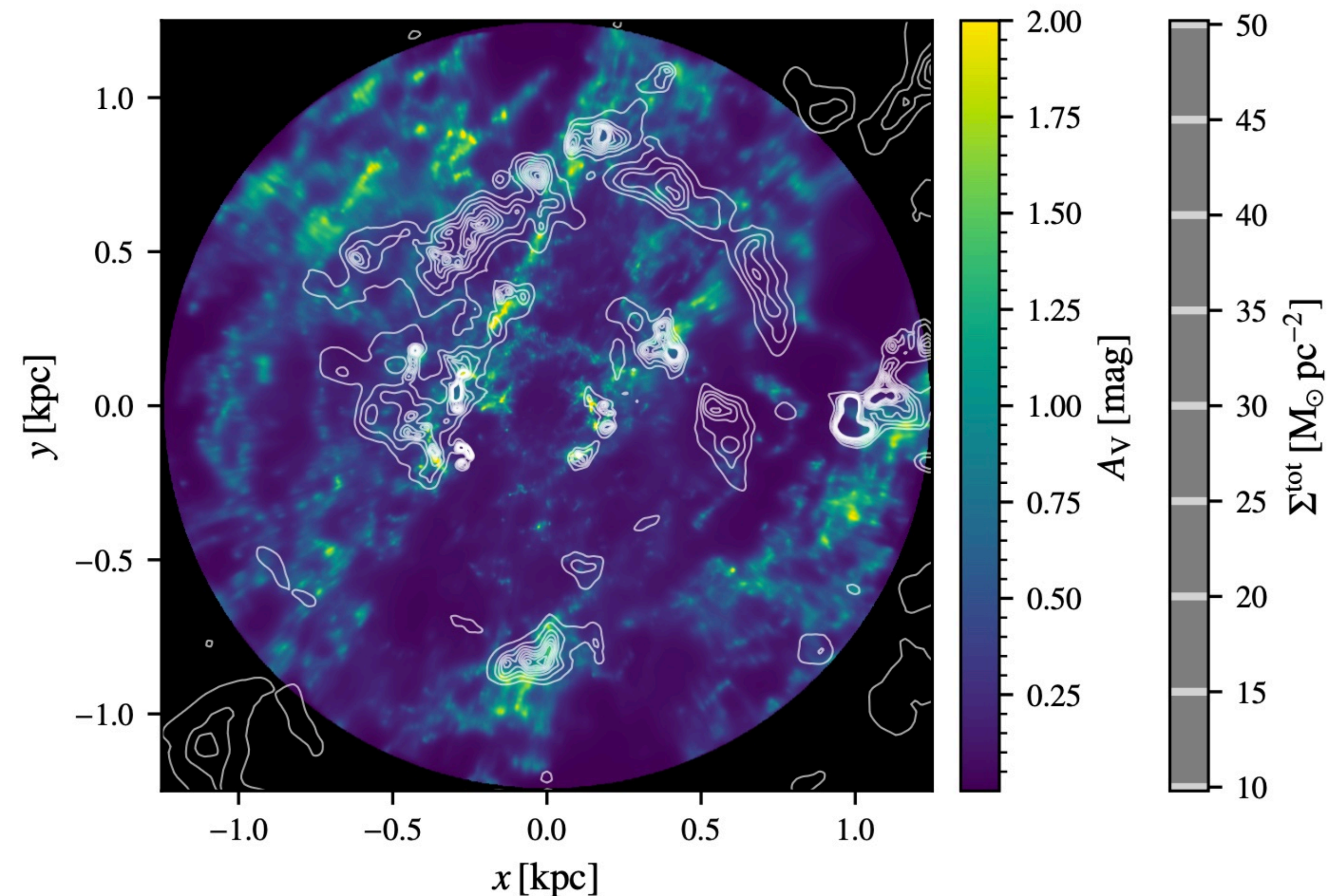
Frank et al. 2021

Edenhofer et al. 2024 - Dust around the Sun



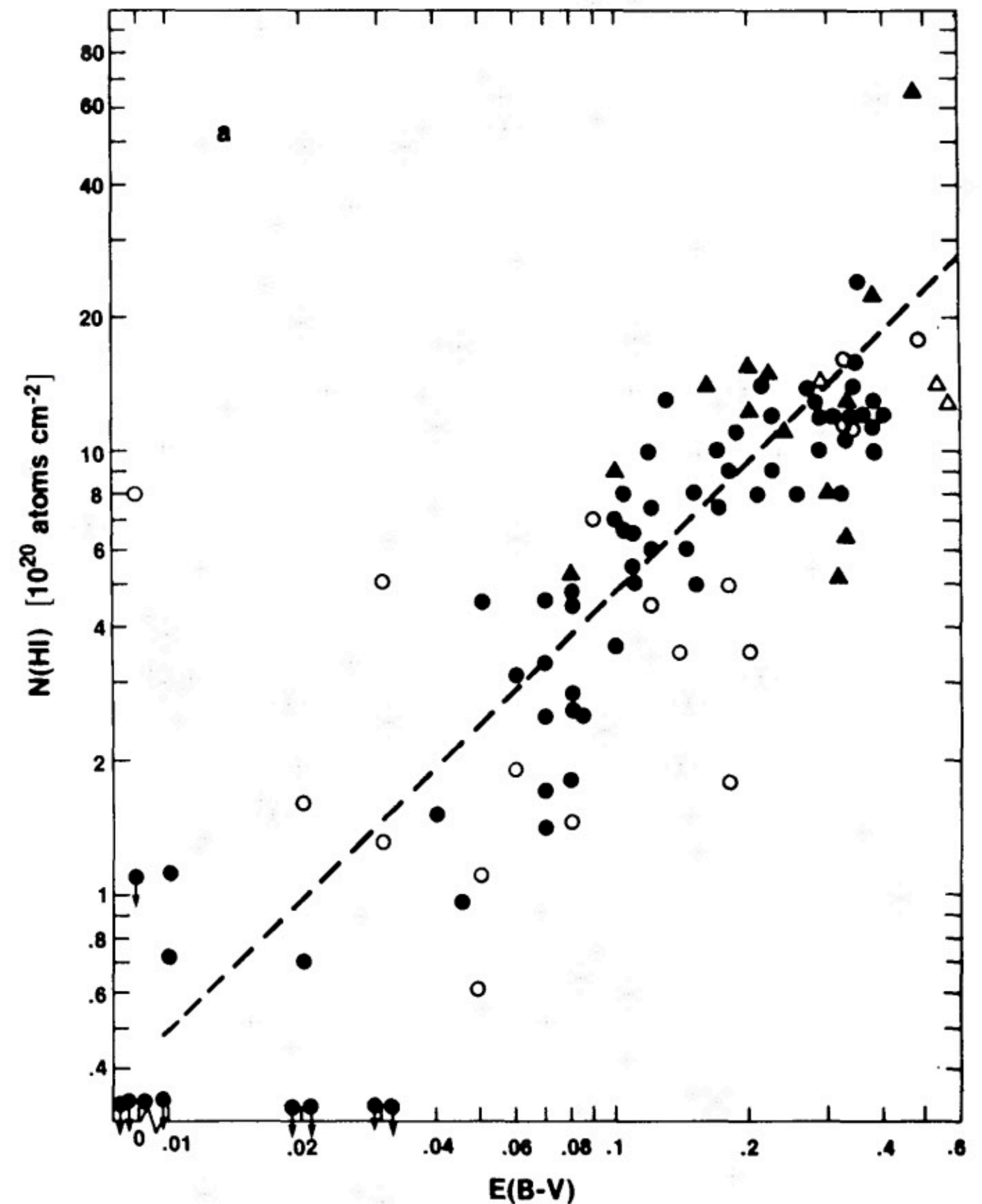
Inconsistencies between maps

- Known correlation of hydrogen gas and interstellar dust
- Comparing the local region around the sun in both maps reveals
 - Some areas overlap well
 - Others do not
 - Some parts only have atomic hydrogen gas



My way forward

- Known correlation of hydrogen gas and interstellar dust
- Map hydrogen gas and interstellar dust simultaneously using Variational Inference
- Combine HI4PI observations and *Gaia* space satellite
- Connect the two components over their correlation
- Let both influence the other one



Bohlin, Savage & Drake 1978

Using Bayesian inference methods, we can construct a three-dimensional map of multiple components of the Milky Way Galaxy by including their correlations to improve the quality of the mappings.