Data-driven Generative Models of Stellar Spectra

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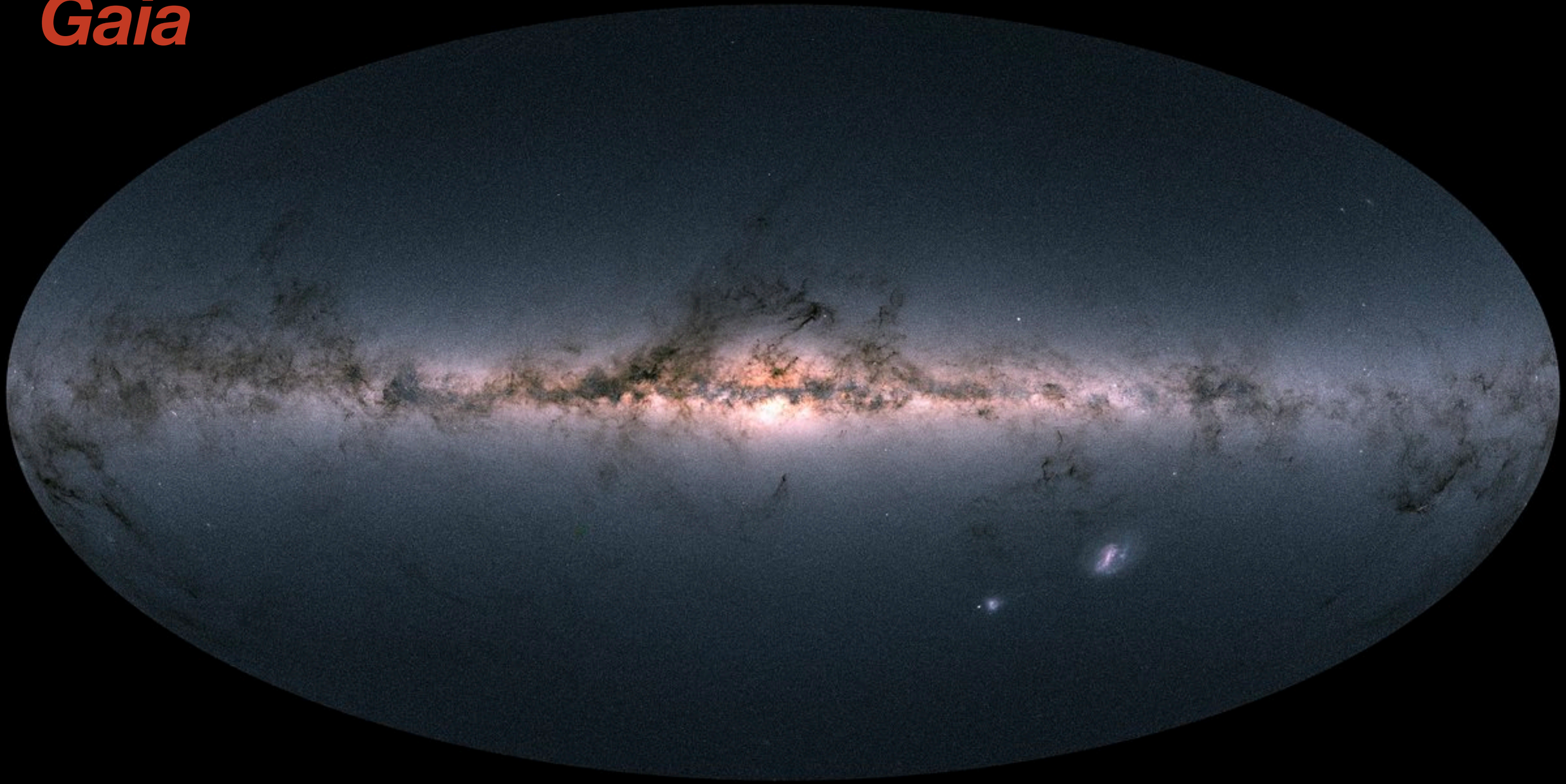
Stars and the Milky Way

- Stars are important tracers of **dark matter** and the **structure and history of our galaxy** (the Milky Way)
- But we need to measure **kinematics** (position and motion) and **intrinsic stellar properties** (composition, age, mass, .) to use them as such
- (OK fine stars are also interesting on their own!)

Gaia



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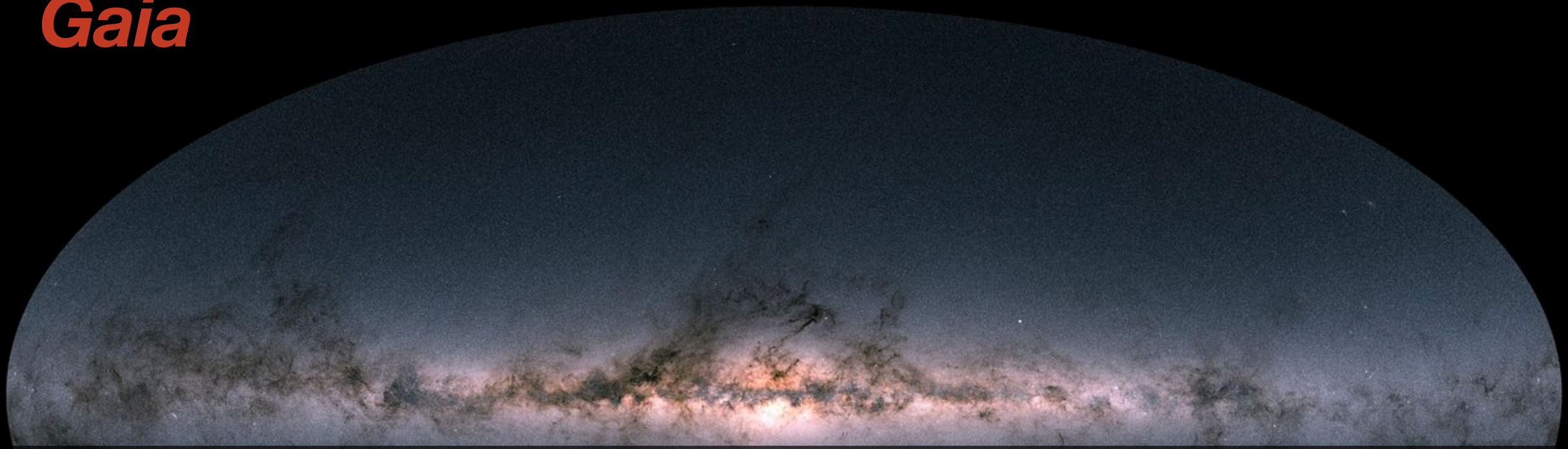

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- For example, the *Gaia Mission* measures incredibly precise parallaxes and proper motions for nearly 2 billion stars in the Milky Way

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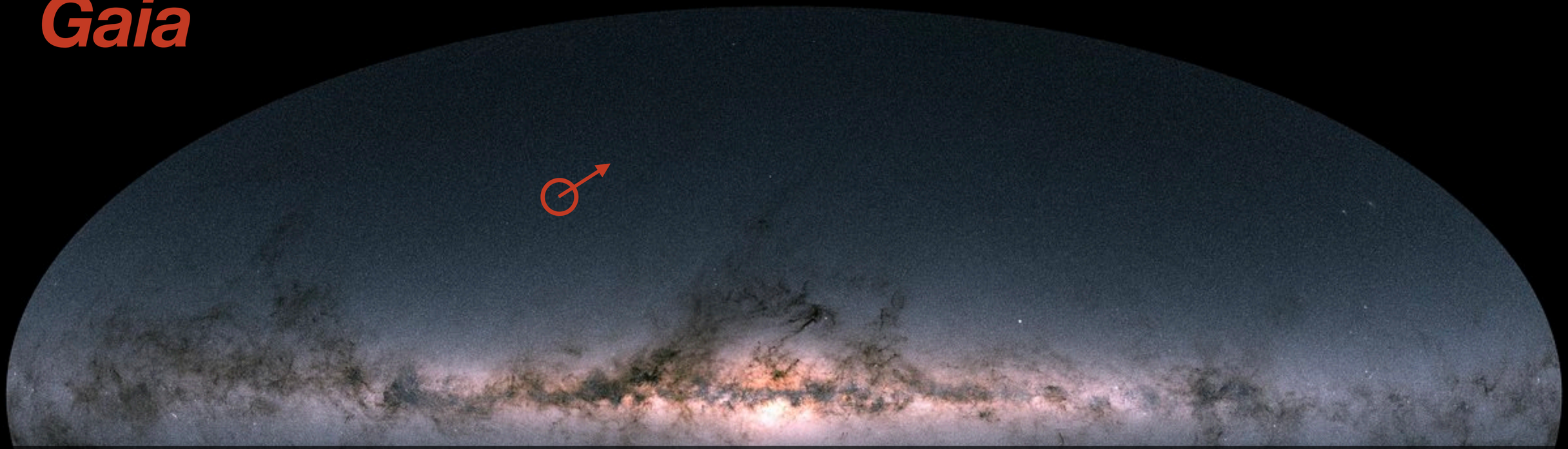

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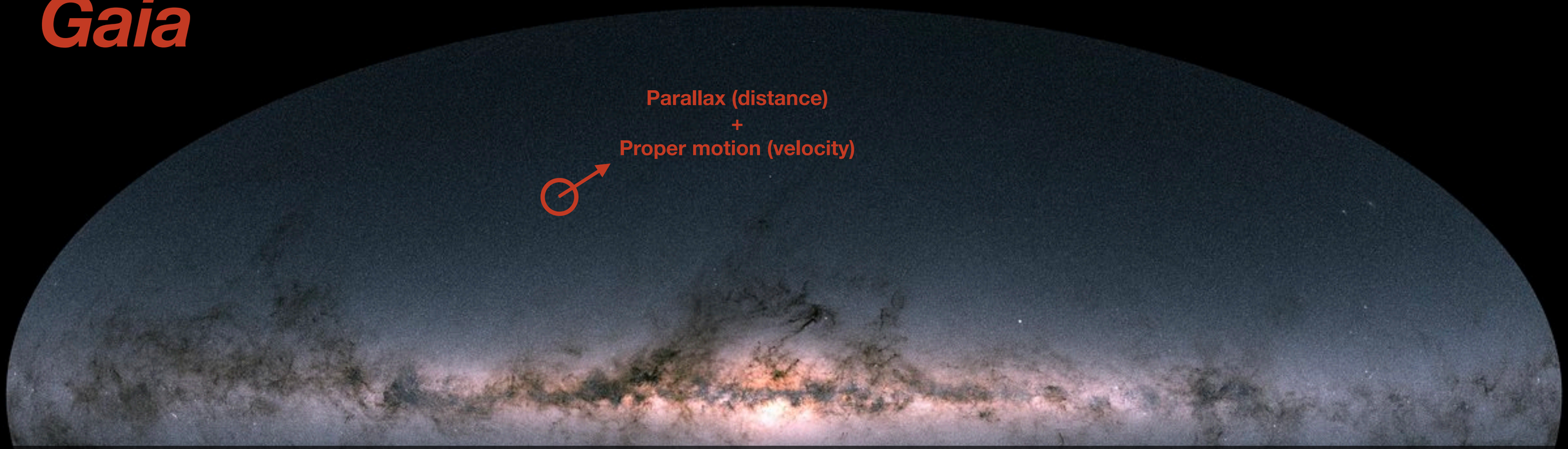

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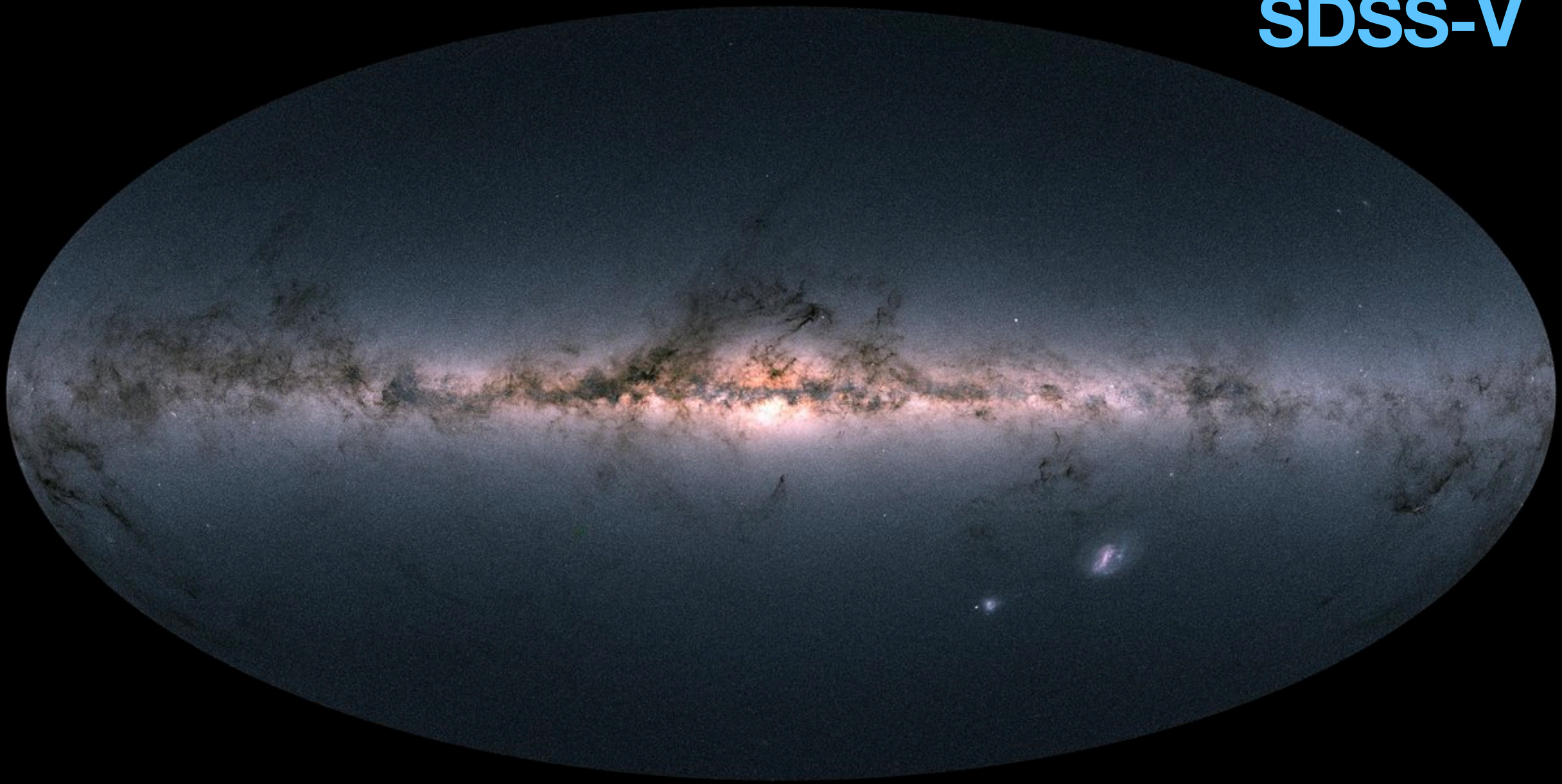
SDSS-V

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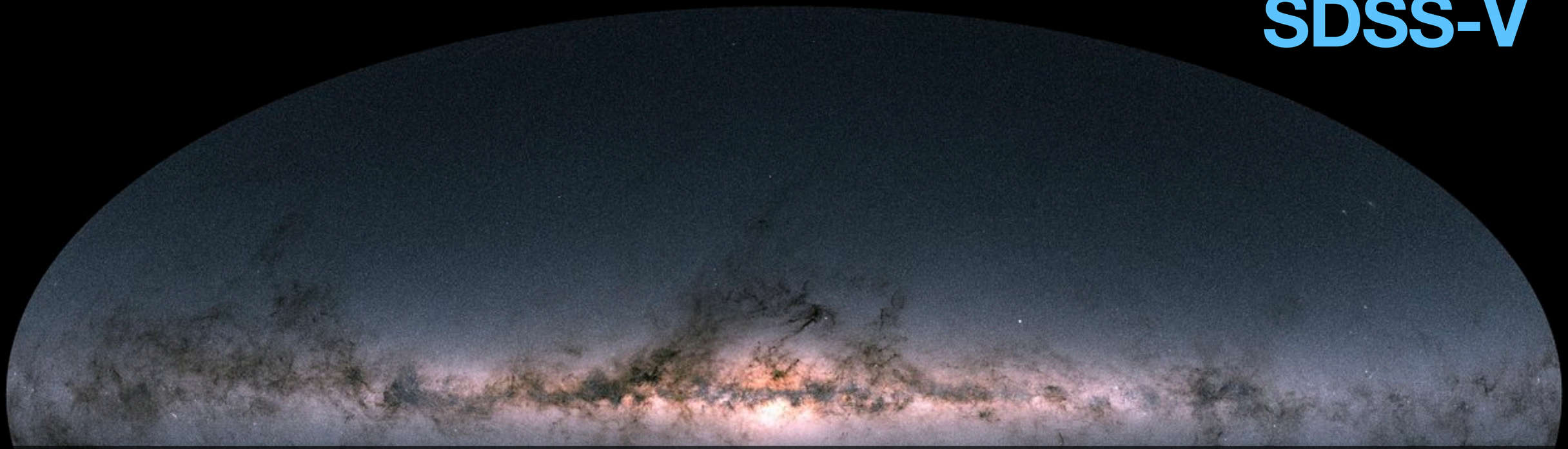
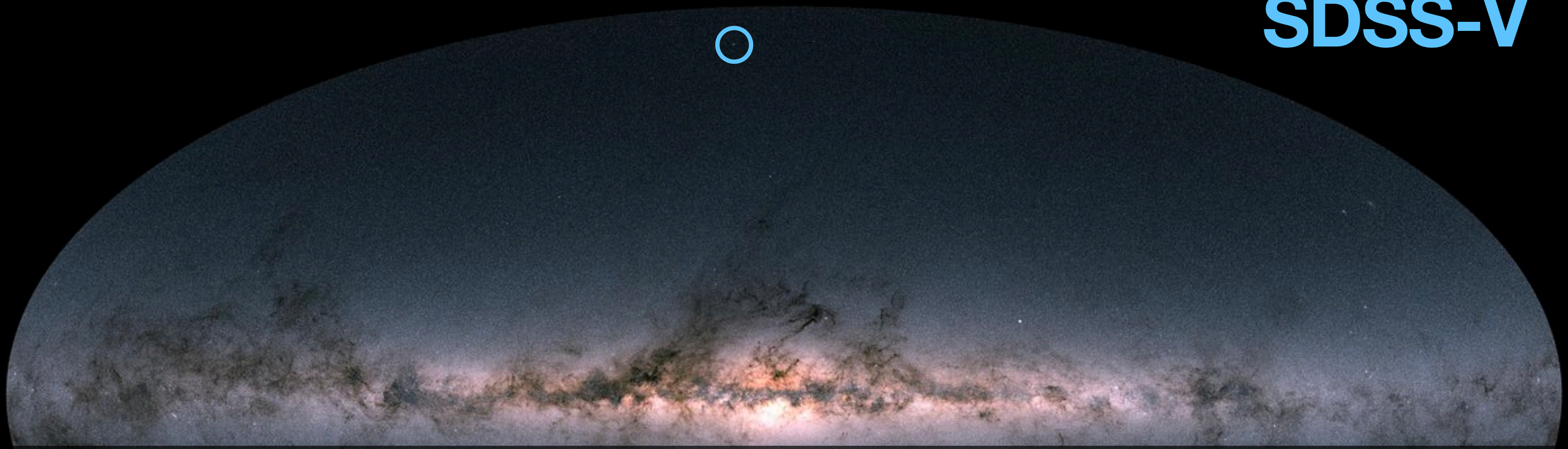


- Data from *Gaia* is now supplemented by ground-based surveys that measure stellar spectra for millions of stars
- Spectra capture the brightness of stars as a function of wavelength, which encodes the compositions of different elements and the evolutionary state of the stars

SDSS-V



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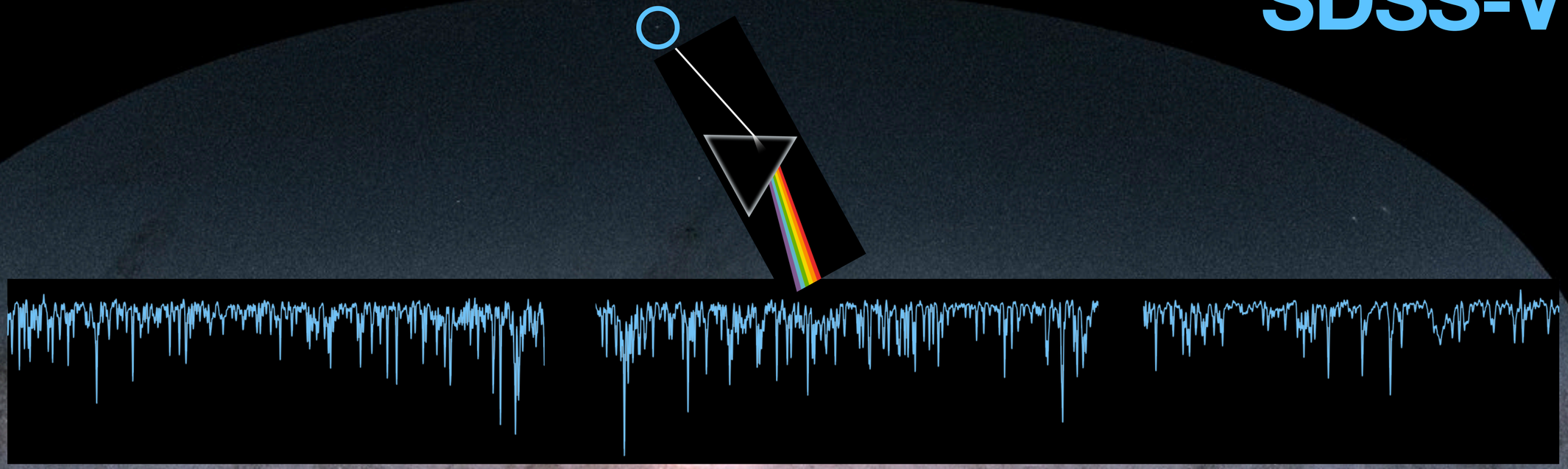

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- Combining stellar kinematic + compositions (for example) enables disentangling the Galaxy's complex history and present dynamical state

NGC 6744
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Gaia + SDSS-V

- But even *Gaia* has its limits: We can only accurately measure distances within the nearest ~1/8th of the Galaxy using the parallaxes from *Gaia* alone
- Also, spectroscopic data analysis has limitations: Most methods rely on stellar models that do not accurately match the precise data we have
- We want to use *Gaia* data to improve stellar parameter inferences, which will then feed back into enabling more precise distance measurements for far away stars

Goals

- Develop a data-driven, generative statistical model for stellar parameter inference with spectra + *Gaia* data (Local Linear Latent Variable Model?!)
- Use this framework to measure improved distances, ages, dust extinctions, and stellar compositions for *Gaia* and SDSS-V stars
- Use the resulting catalog to study the stellar population structure of the Galaxy

- **You'll learn:** Stellar astronomy, Galactic "archaeology", statistical model building, machine learning (for comparisons to our model), software development