



FJÁRSJÓÐSLEIT MEÐAL DVERGVETRARBRAUTA



Ása Skúladóttir
Háskólinn í Flórens



UNIVERSITÀ
DEGLI STUDI
FIRENZE

STJARNFORNLEIFAFRÆÐINGUR

- Fortíðin er skrifuð í stjörnurnar -

Flórens



Romain Lucchesi

Paranal, Chile



ESO

Paranal, Chile

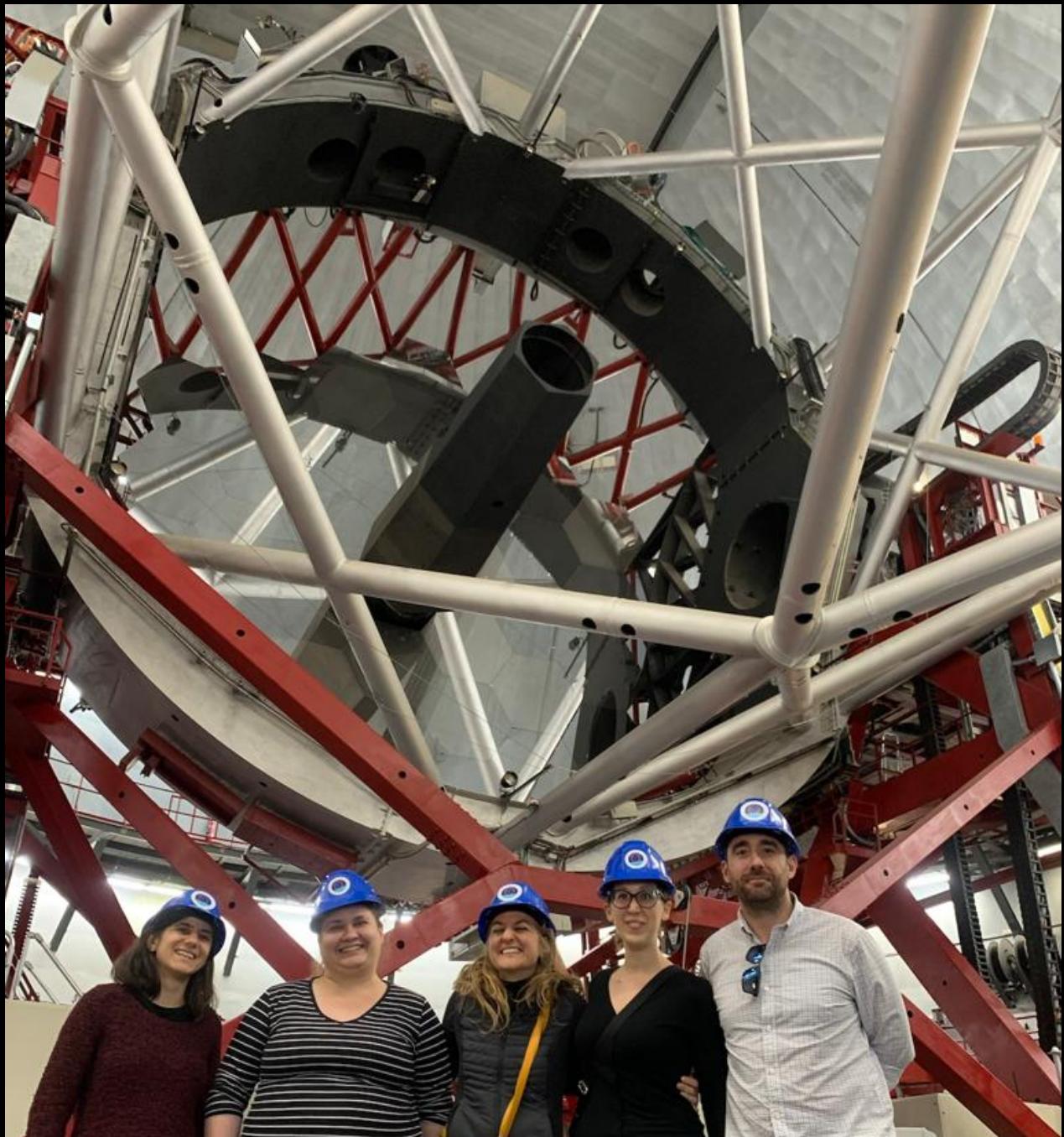


ESO

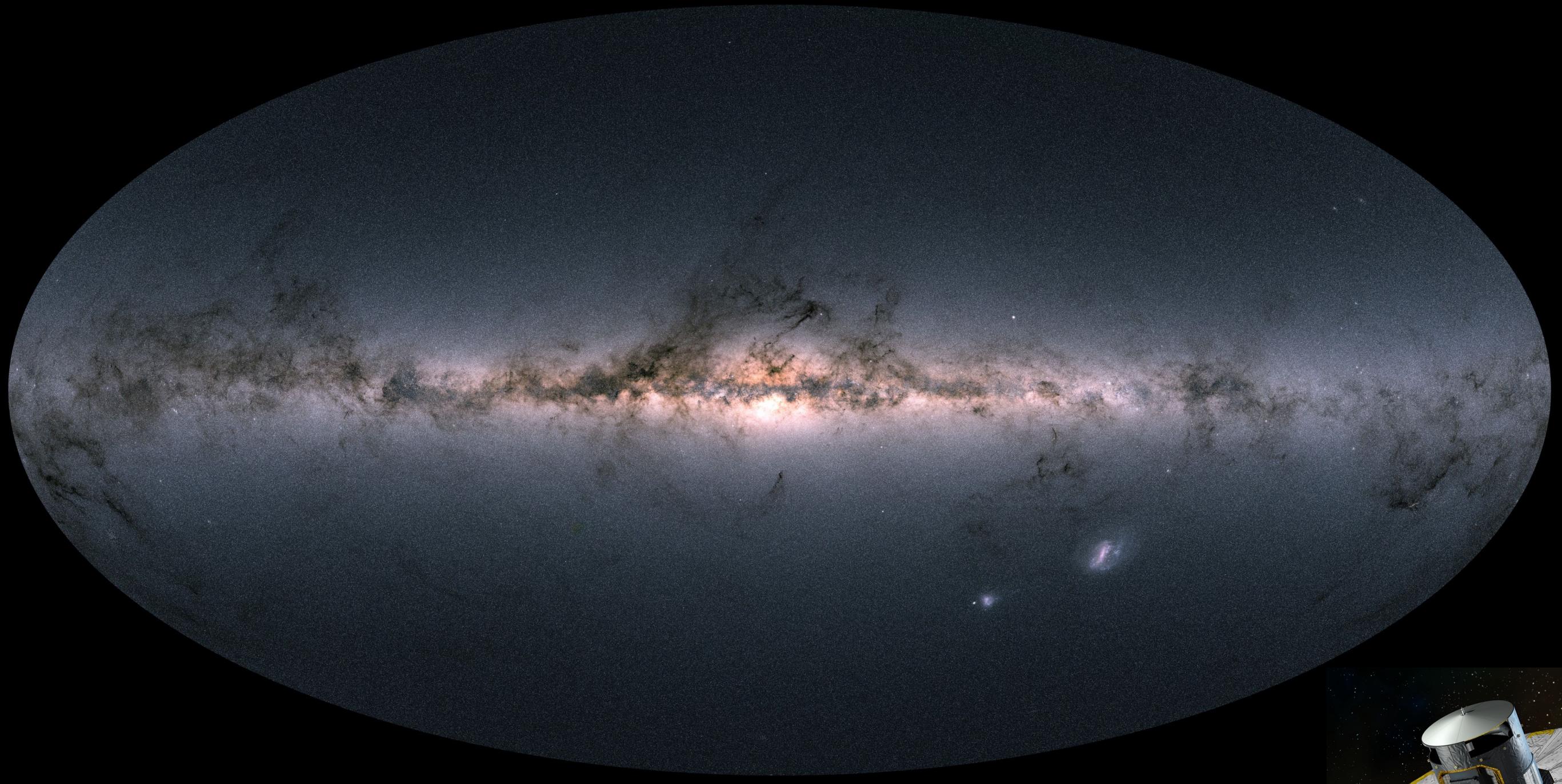
La Palma, Kanaríeyjar



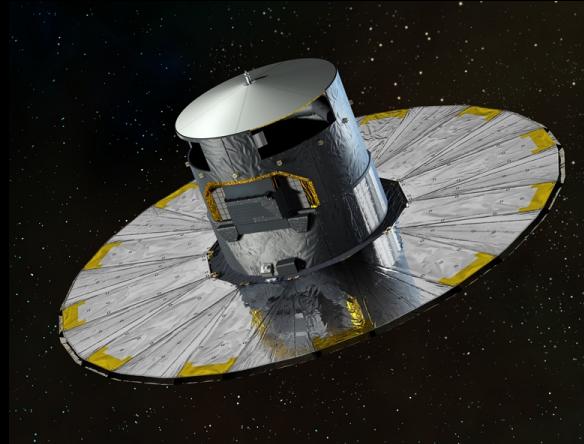
La Palma, Kanaríeyjar



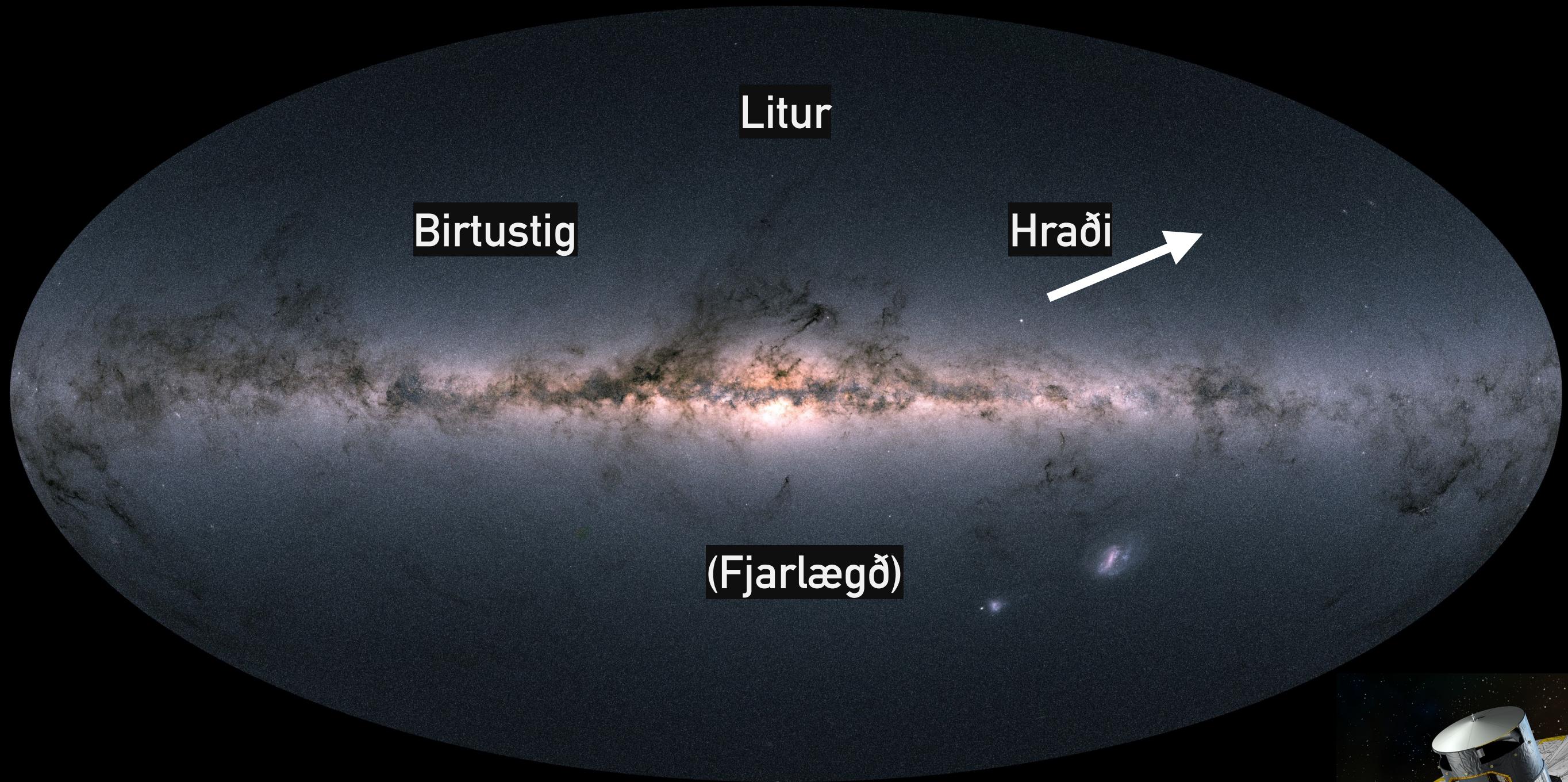
GAIA GEIMSJÓNAUKINN - 1500 MILLJÓN STJÖRNUR



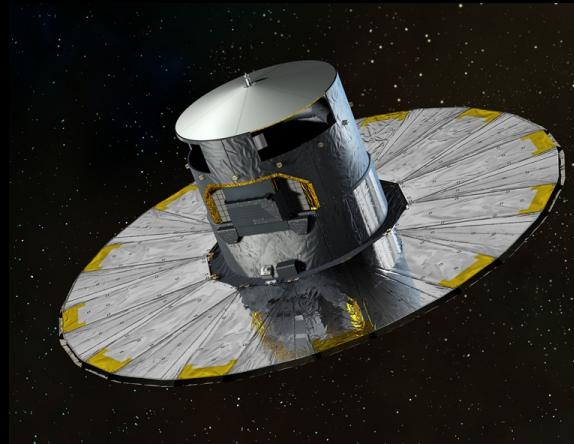
Youtube: Full-sky movie of the Gaia DR2 catalogue and the motions of the stars (with zoom in)



GAIA GEIMSJÓNAUKINN - 1500 MILLJÓN STJÖRNUR



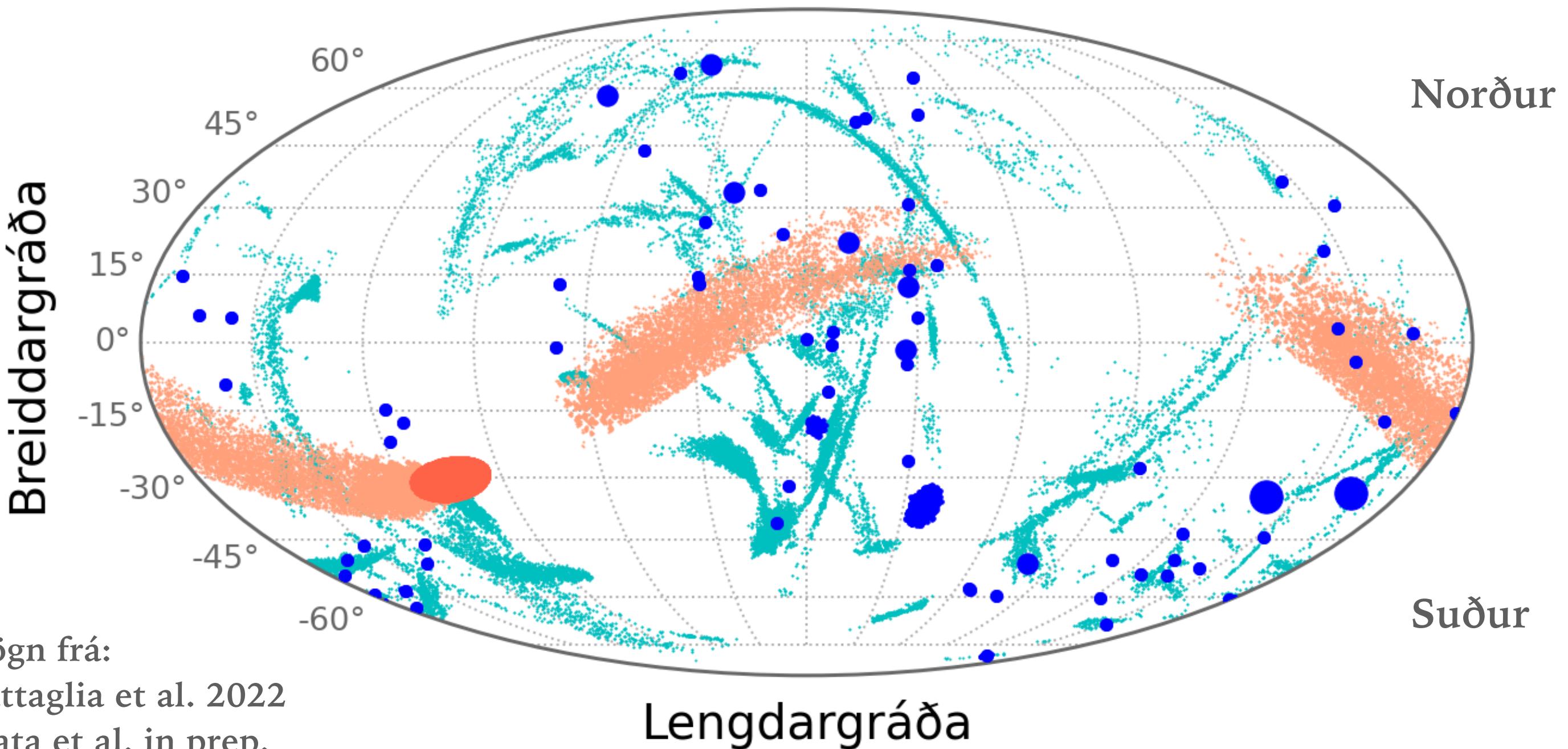
Youtube: Full-sky movie of the Gaia DR2 catalogue and the motions of the stars (with zoom in)



DVERGVETRARBRAUTIR

- Bogamaðurinn
- Dvergvetrarbrautir
- Stjörnustraumar

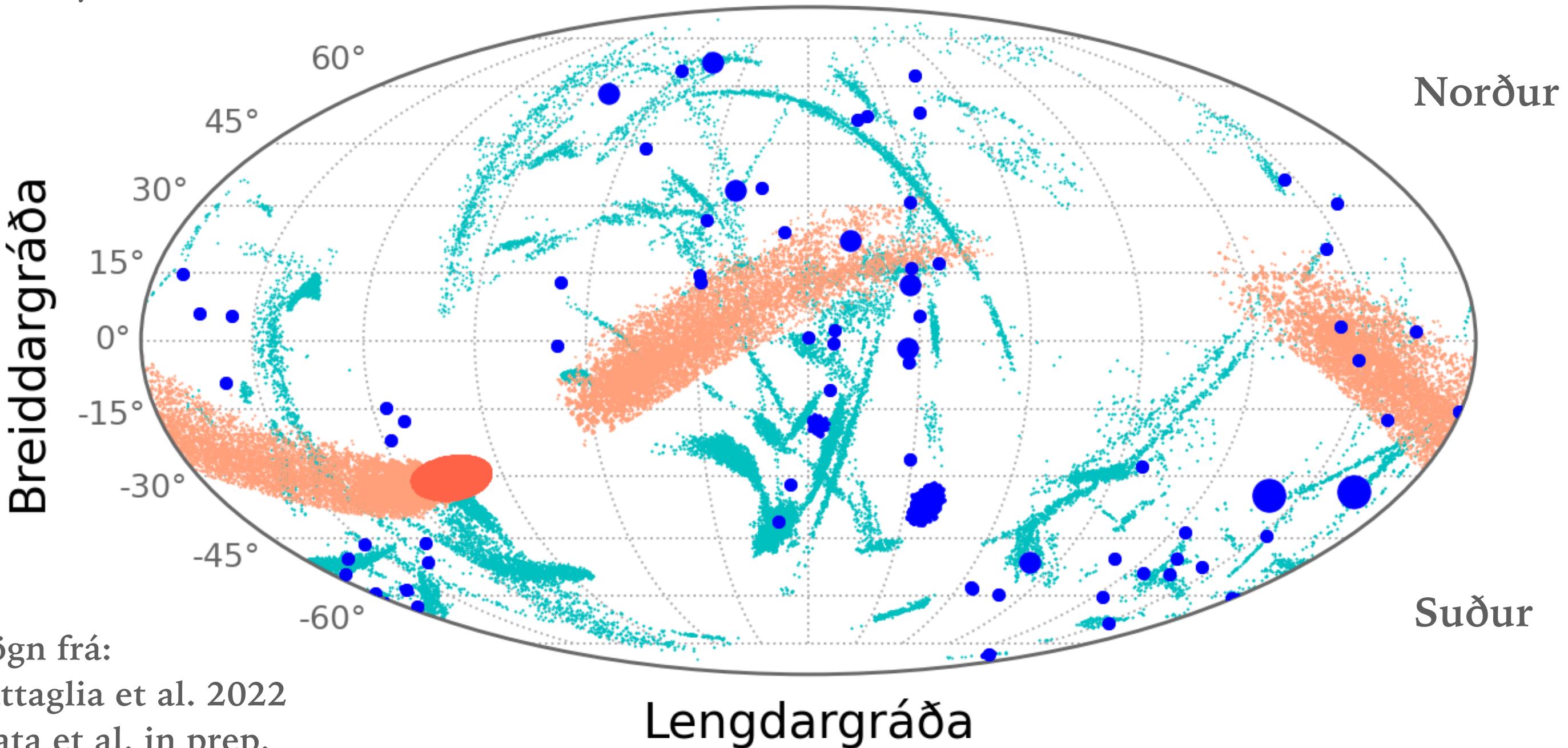
► Vetrarbrautin okkar hefur yfir 70 minni **dvergvetrarbrautir** á sporbraut um sig, og tugi af **stjörnustraumum**.



DVERGVETRARBRAUTIR

- Bogamaðurinn
- Dvergvetrarbrautir
- Stjörnustraumar

► **Dvergvetrarbrautir:** Algengustu vetrarbrautirnar, fyrstu vetrarbrautirnar til að myndast í heiminum, heimili fyrstu stjarnanna, sameinast til að mynda stærri vetrarbrautir.



Gögn frá:

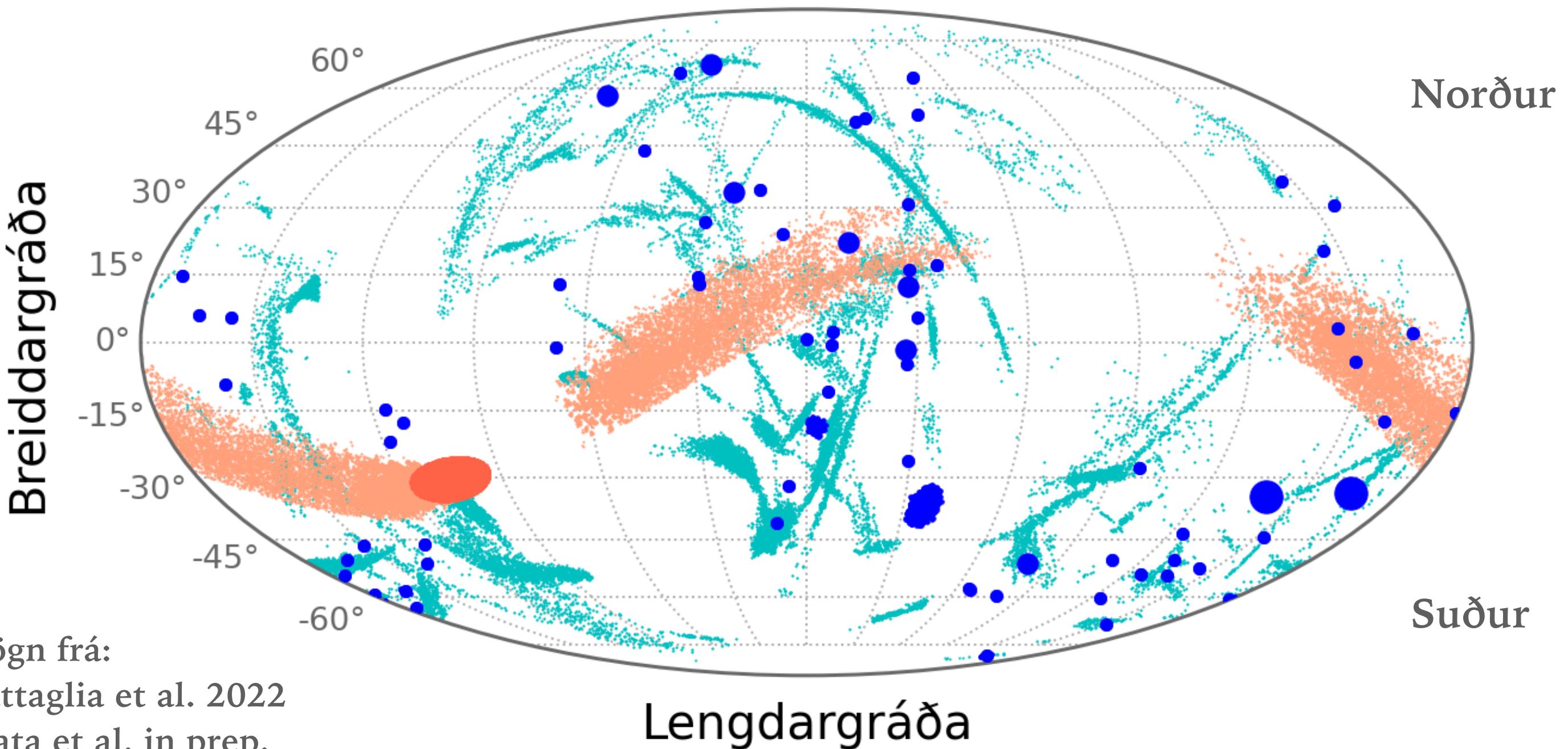
Battaglia et al. 2022

Ibata et al. in prep.

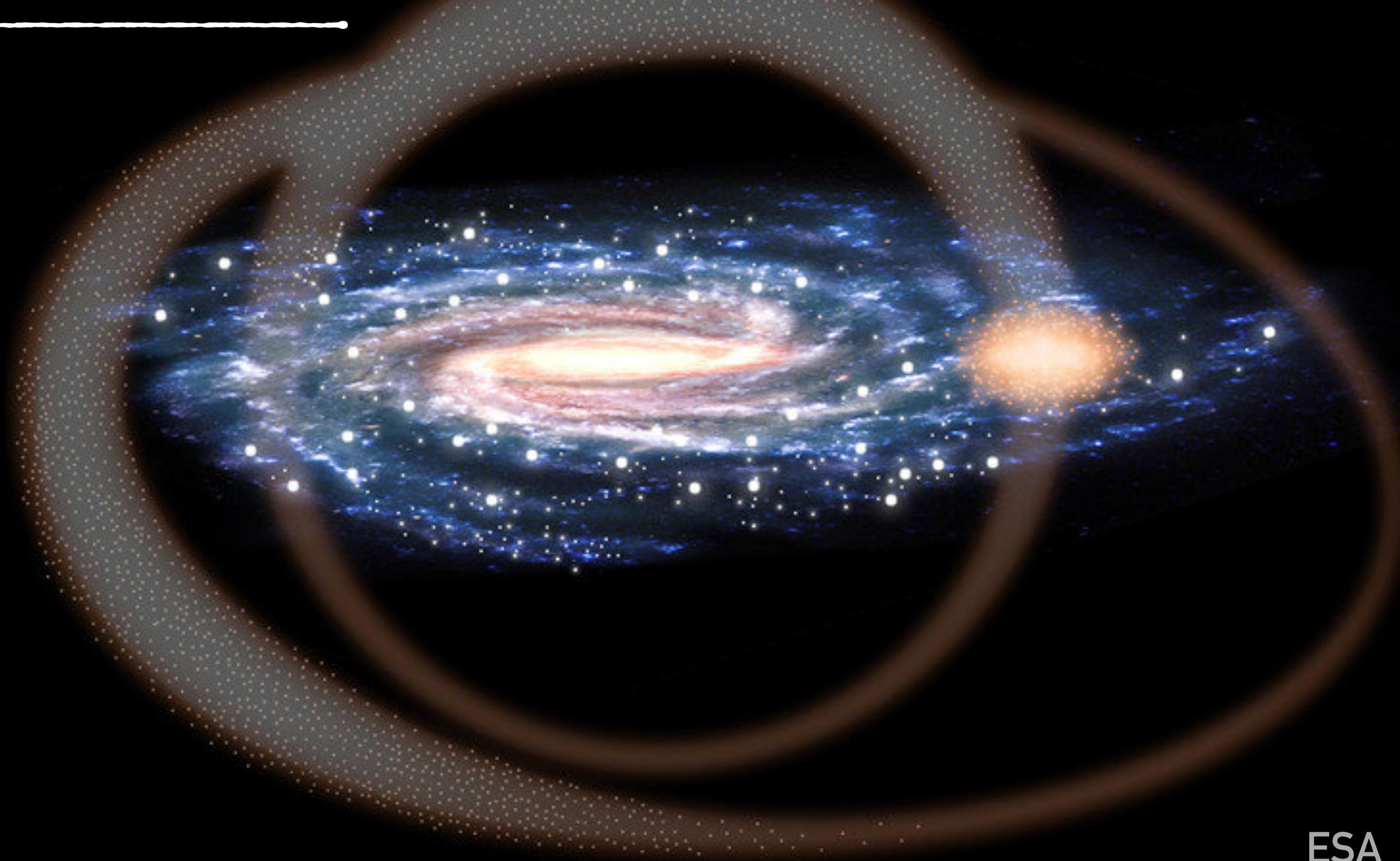
DVERGVETRARBRAUTIR

- Bogamaðurinn
- Dvergvetrarbrautir
- Stjörnustraumar

► **Stjörnustraumar:** Leyfar af gömlum dvergvetrarbrautum sem hafa verið slitnar í sundur og stundum gleyptar af Vetrarbrautinni okkar.



BOGAMAÐURINN

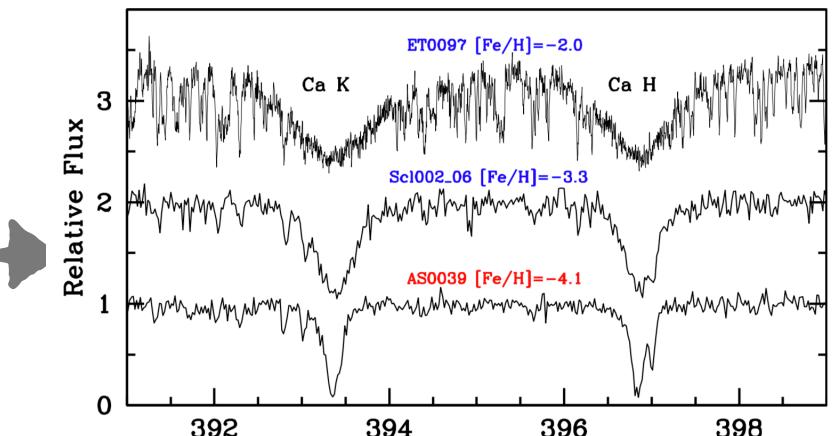
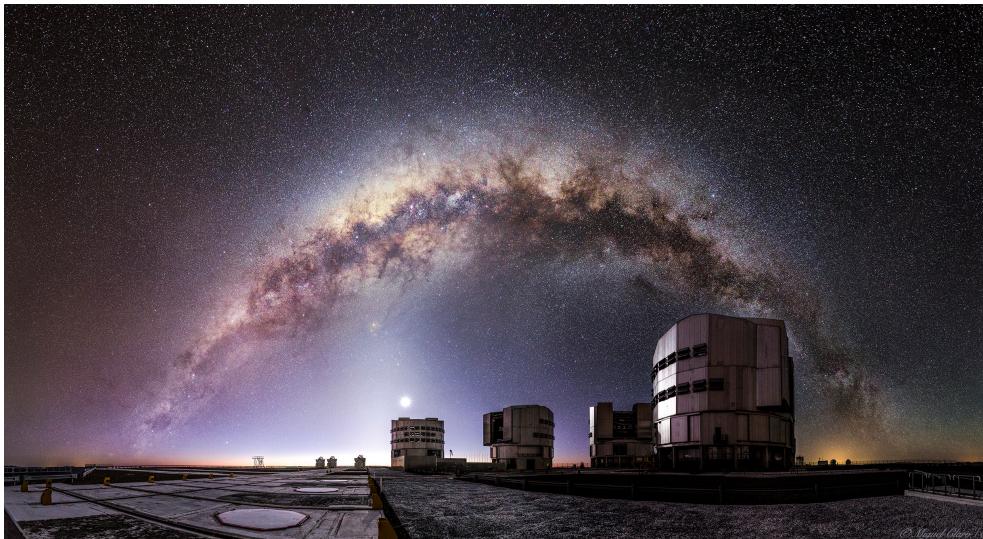


ESA

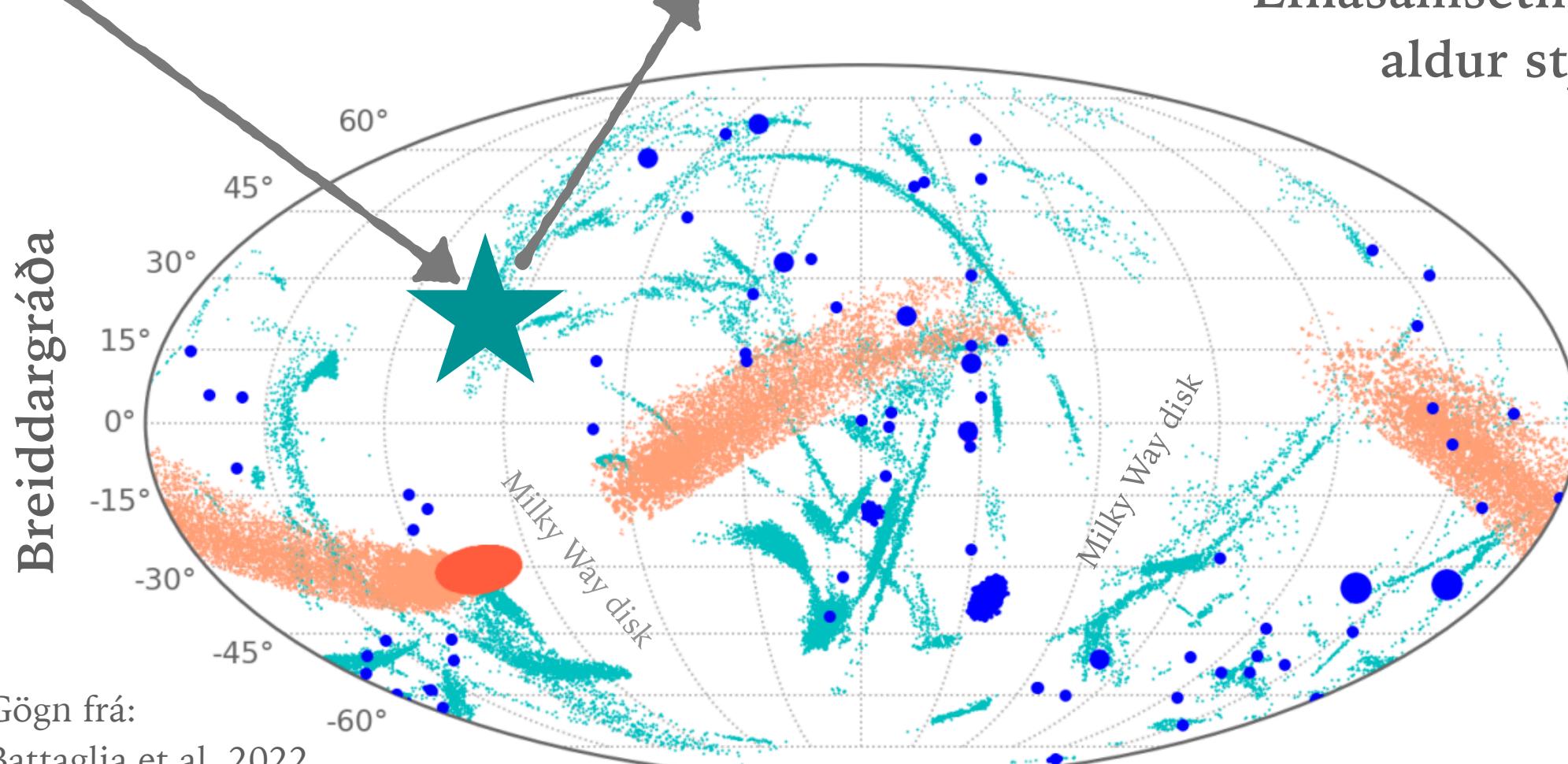
DVERGVETRARBRAUTIR



GAIA



Efnasamsetning, hraði,
aldur stjarna



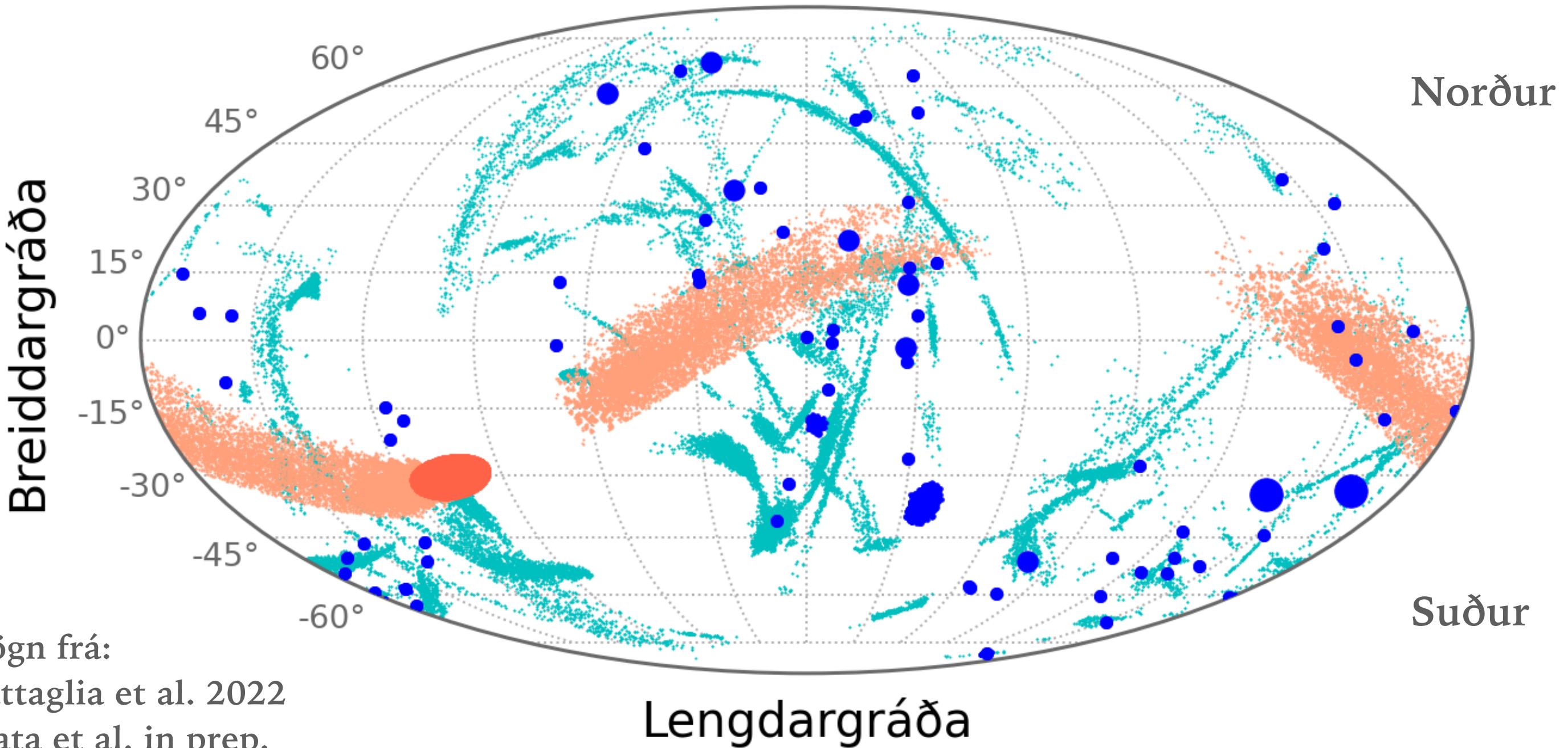
Gögn frá:
Battaglia et al. 2022
Ibata et al. in prep.

Lengdargráða

DVERGVETRARBRAUTIR

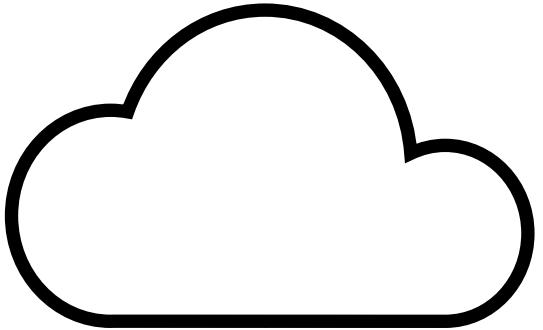
- Bogamaðurinn
- Dvergvetrarbrautir
- Stjörnustraumar

- Uppbygging Vetrarbrautarinnar okkar
- Uppruni frumefnanna



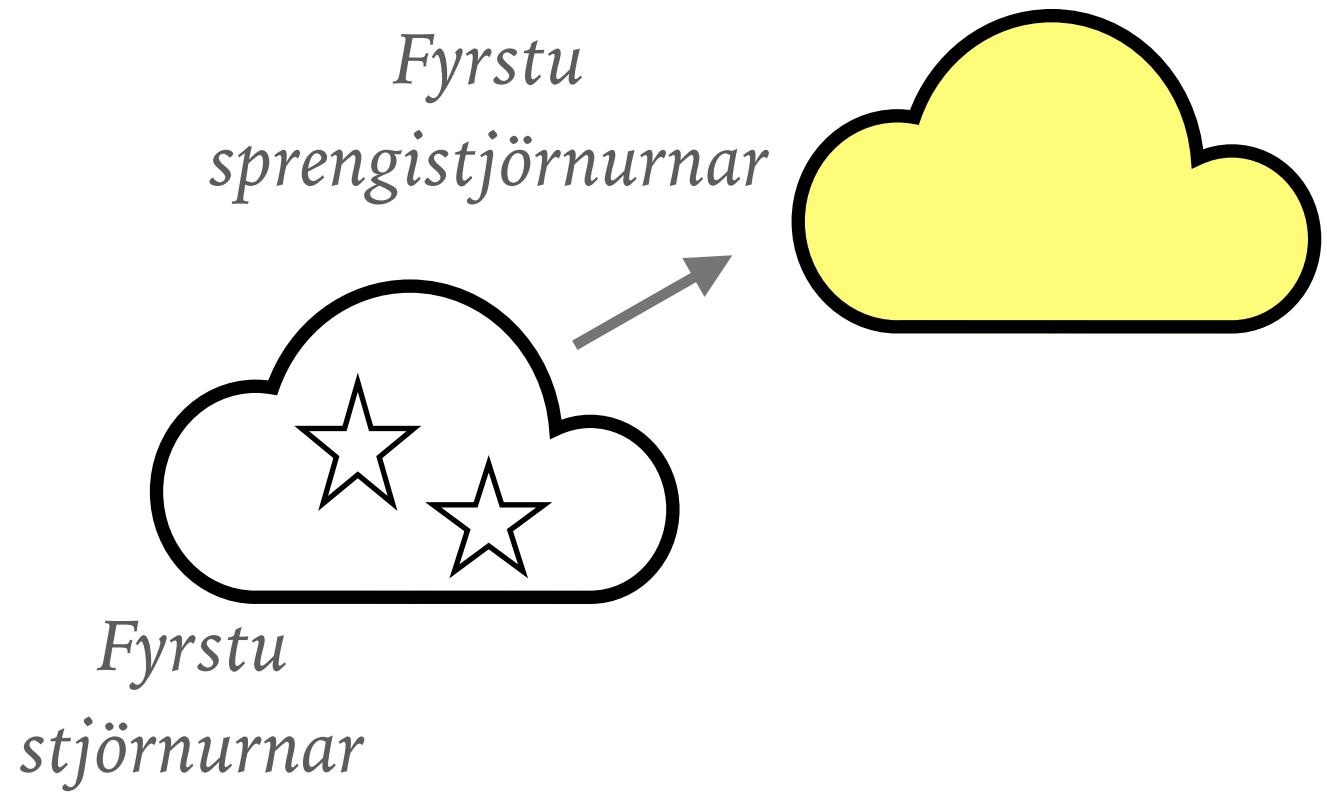
SAGA FRUMEFNANNA

Eftir Stóra hvell voru engin frumefni nema
vetni og helium

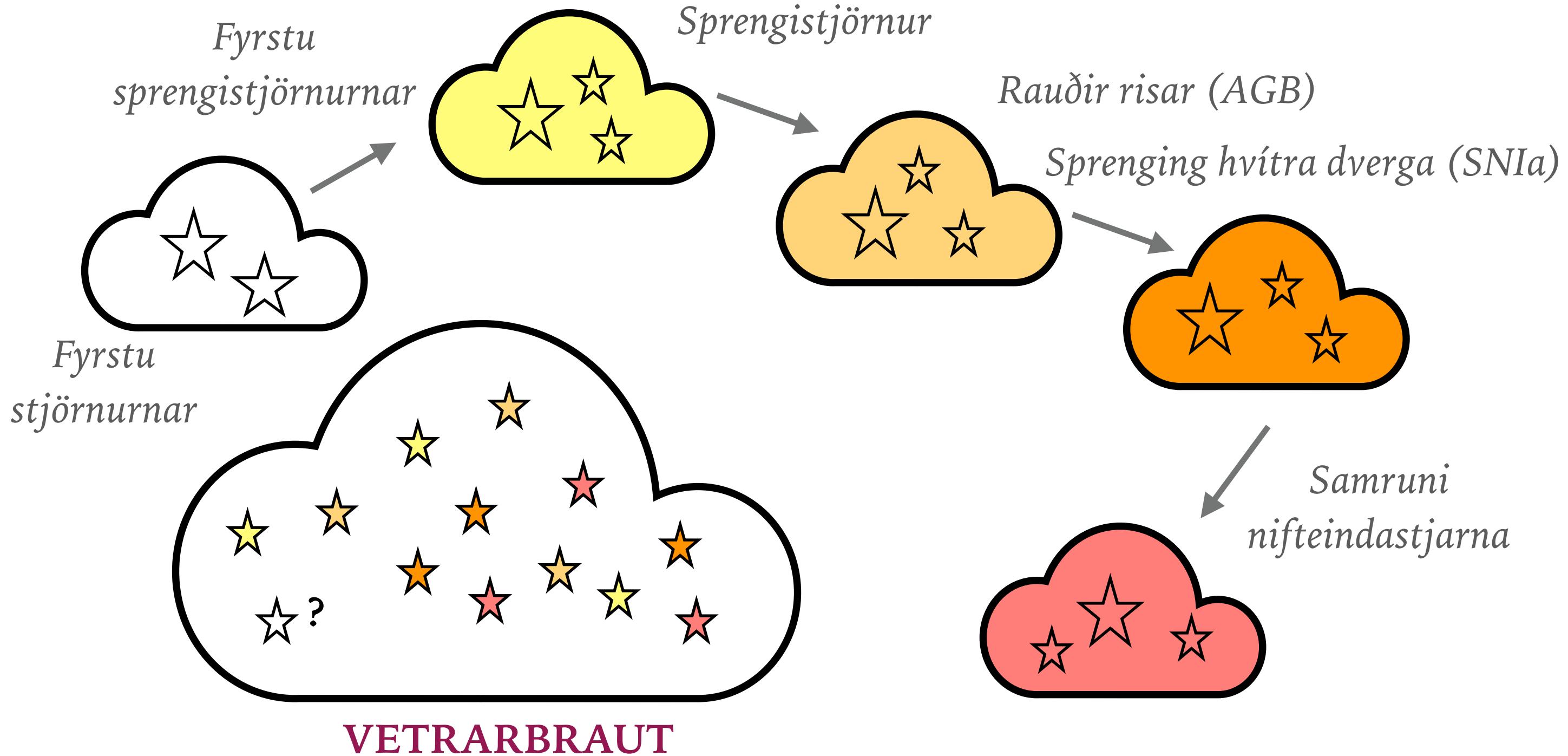


H og He

SAGA FRUMEFNANNA



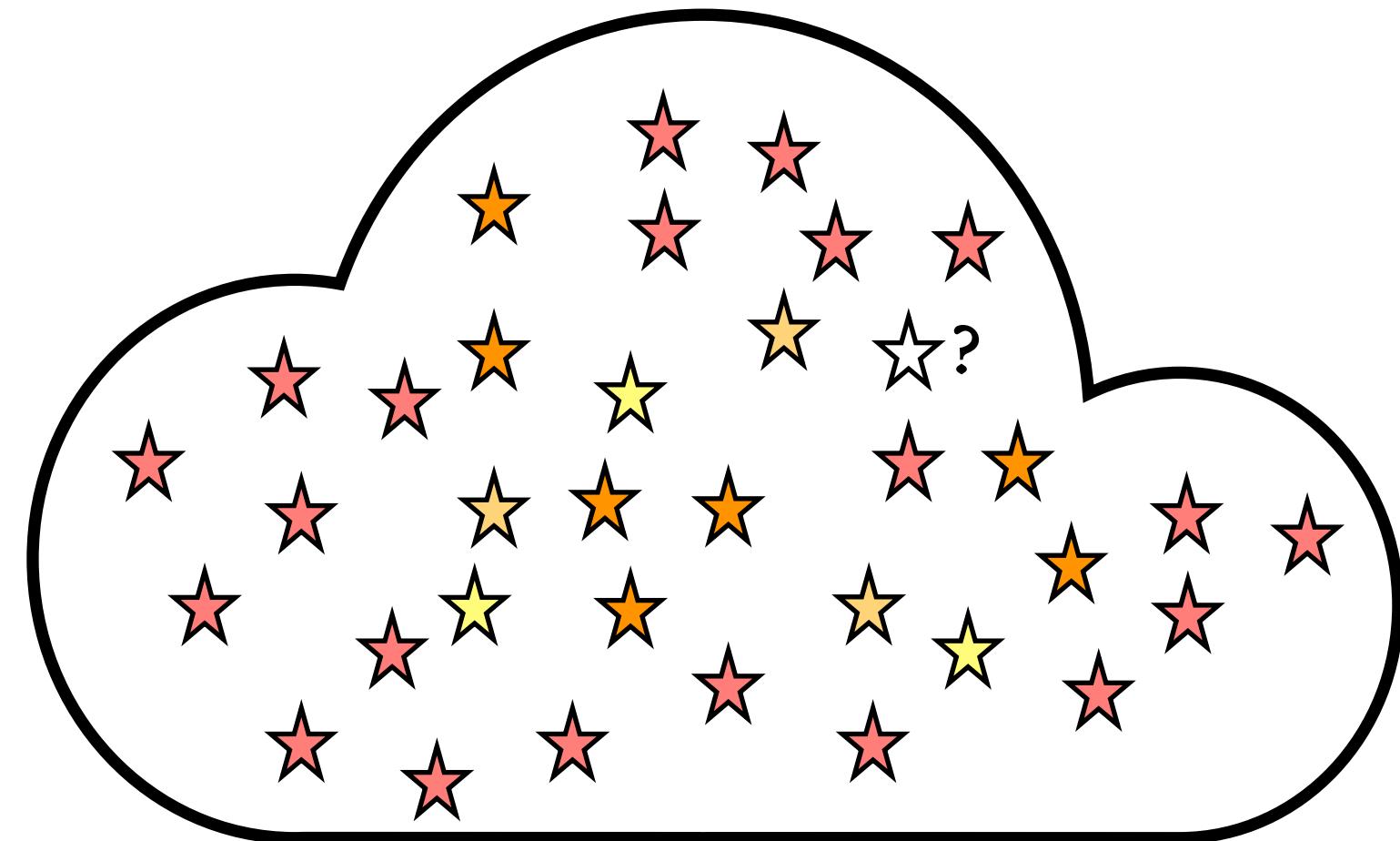
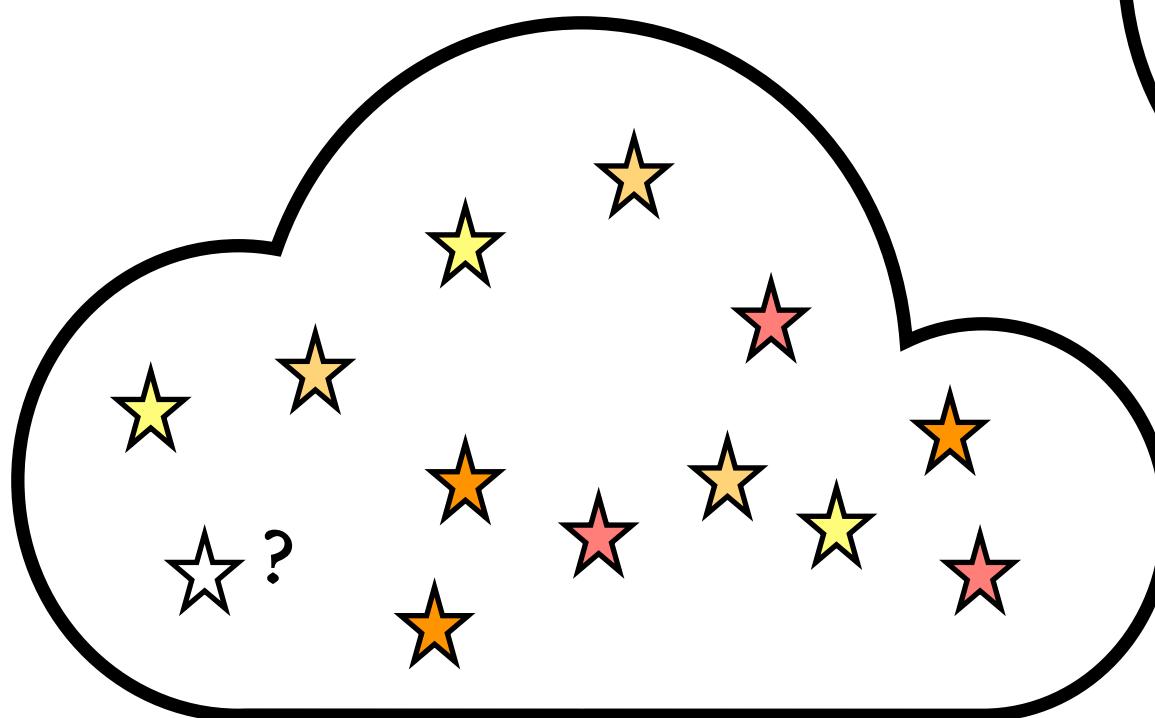
SAGA FRUMEFNANNA



SAGA FRUMEFNANNA



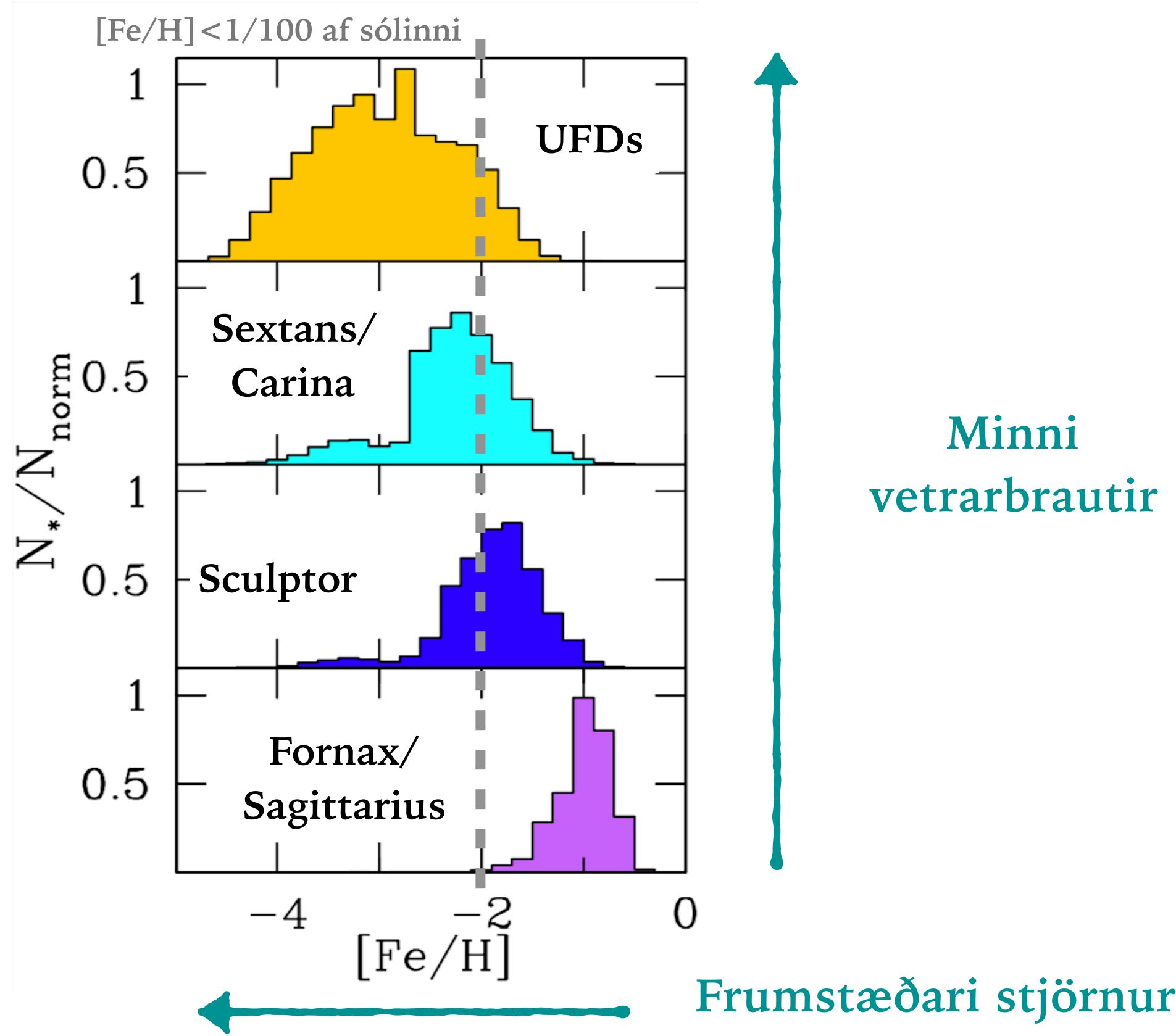
Minni vetrarbrautir eru
frumstæðari



Stærri vetrarbrautir framleiða
meira af frumefnum

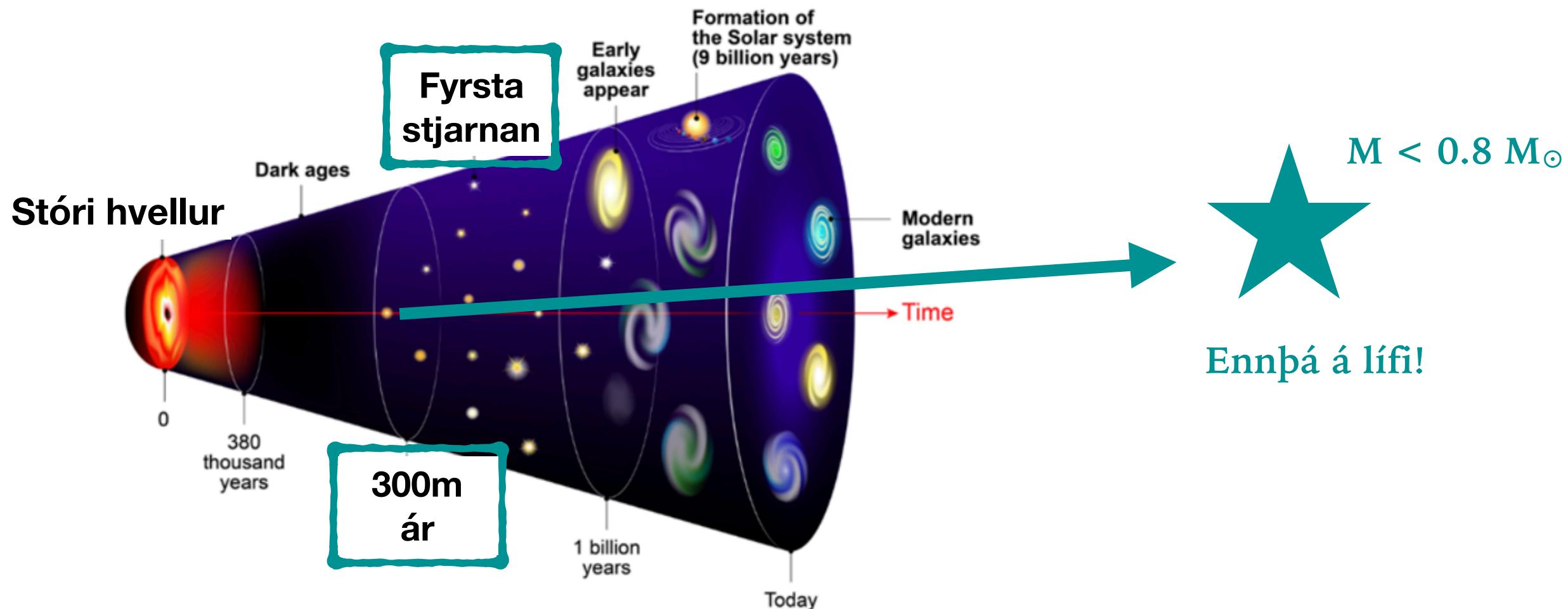
DVERGVETRARBRAUTIR ERU FRUMSTÆÐAR

Frumstæðar
stjörnur geyma
upplýsingar um
fyrstu
stjörnurnar!

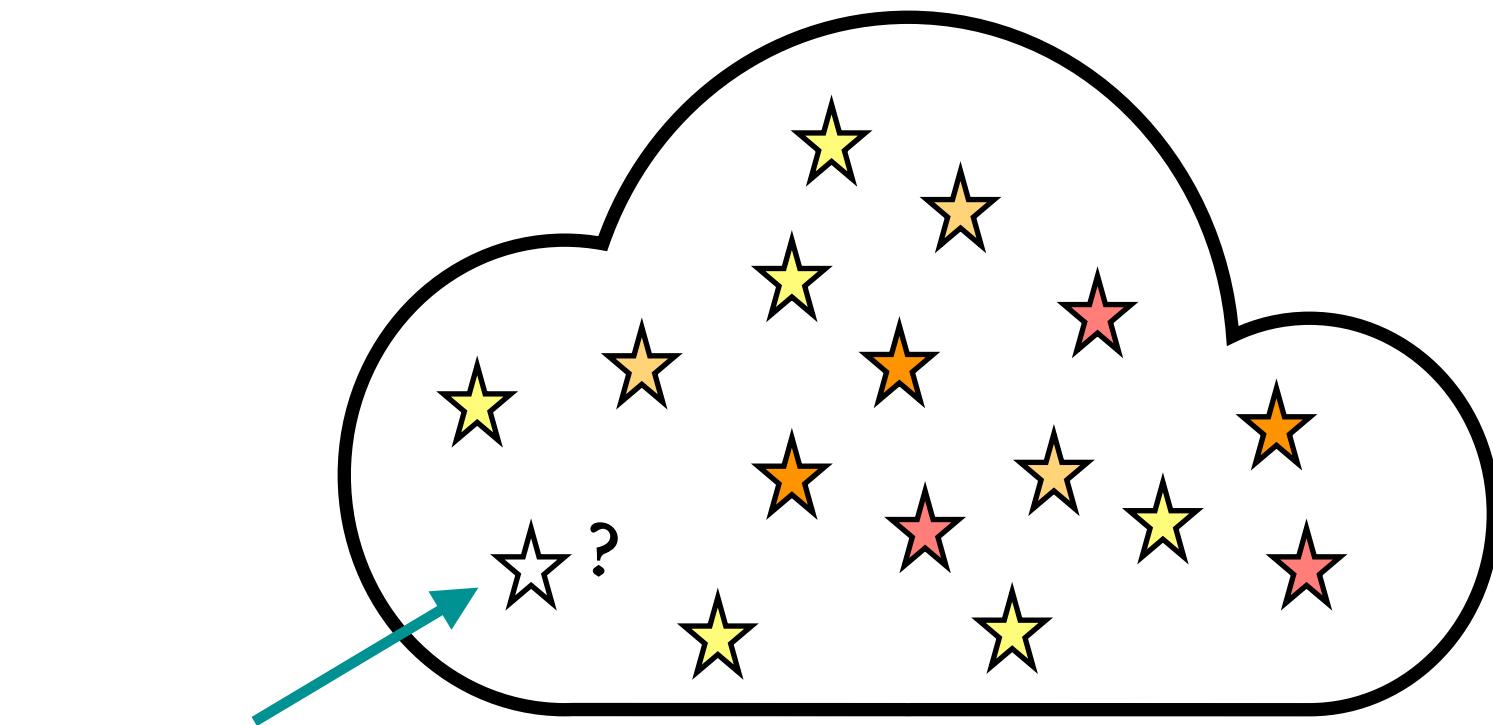


FÝRSTU STJÖRNURNAR

- Fyrstu stjörnurnar eftir Stóra hvell bara gerðar úr vetrni og helíumi.
- Líklega massameiri en stjörnur sem myndast í dag.
- Stjörnur með $M < 0.8 M_{\odot}$ eru ennþá á lífi í dag!
- Engin af þessum stjörnum hefur fundist ennþá!



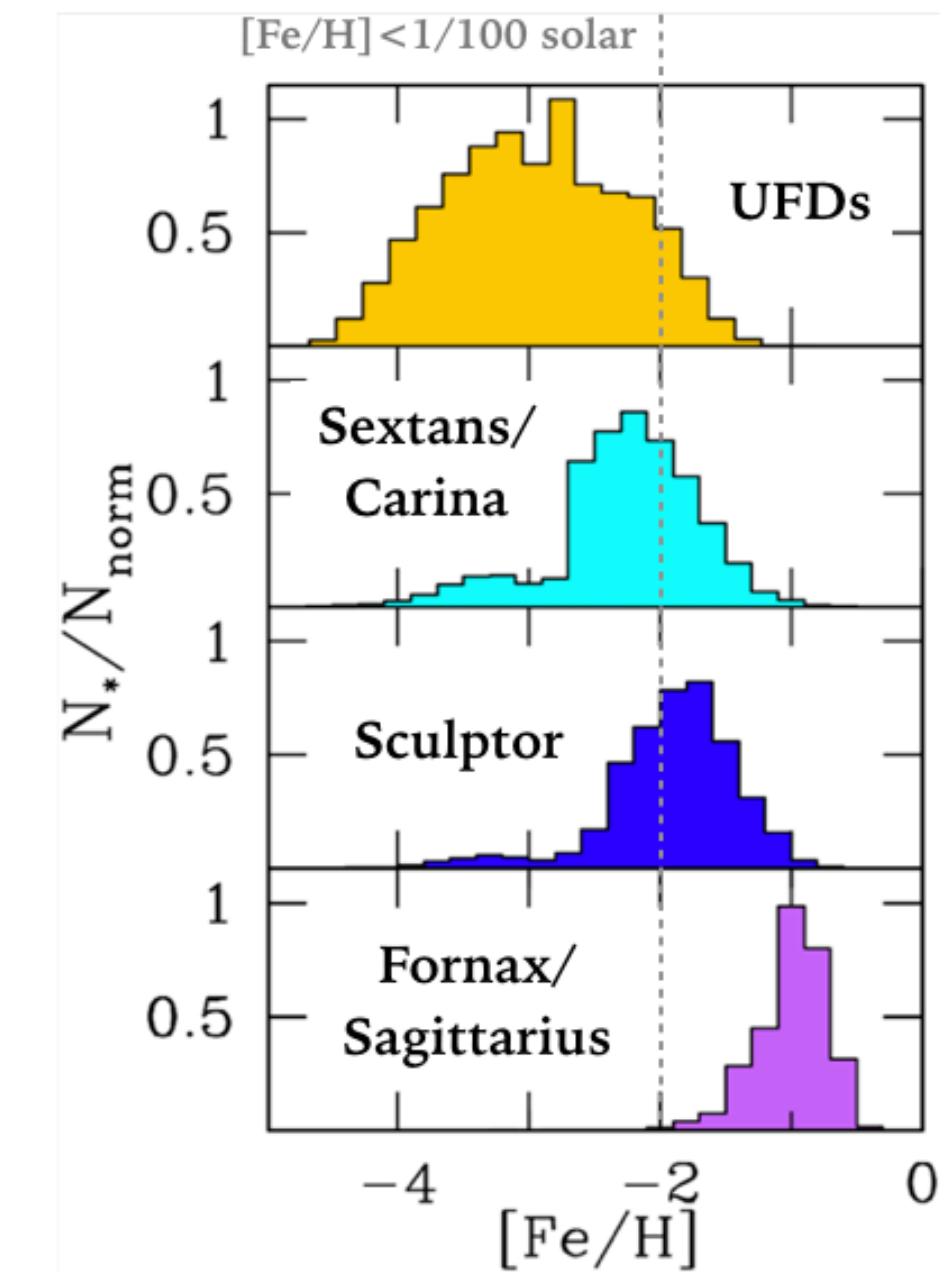
FYRSTU STJÖRNURNAR ENNPÁ Á LÍFI?



*Eru fyrstu
stjörnurnar
ennpá á lífi?*

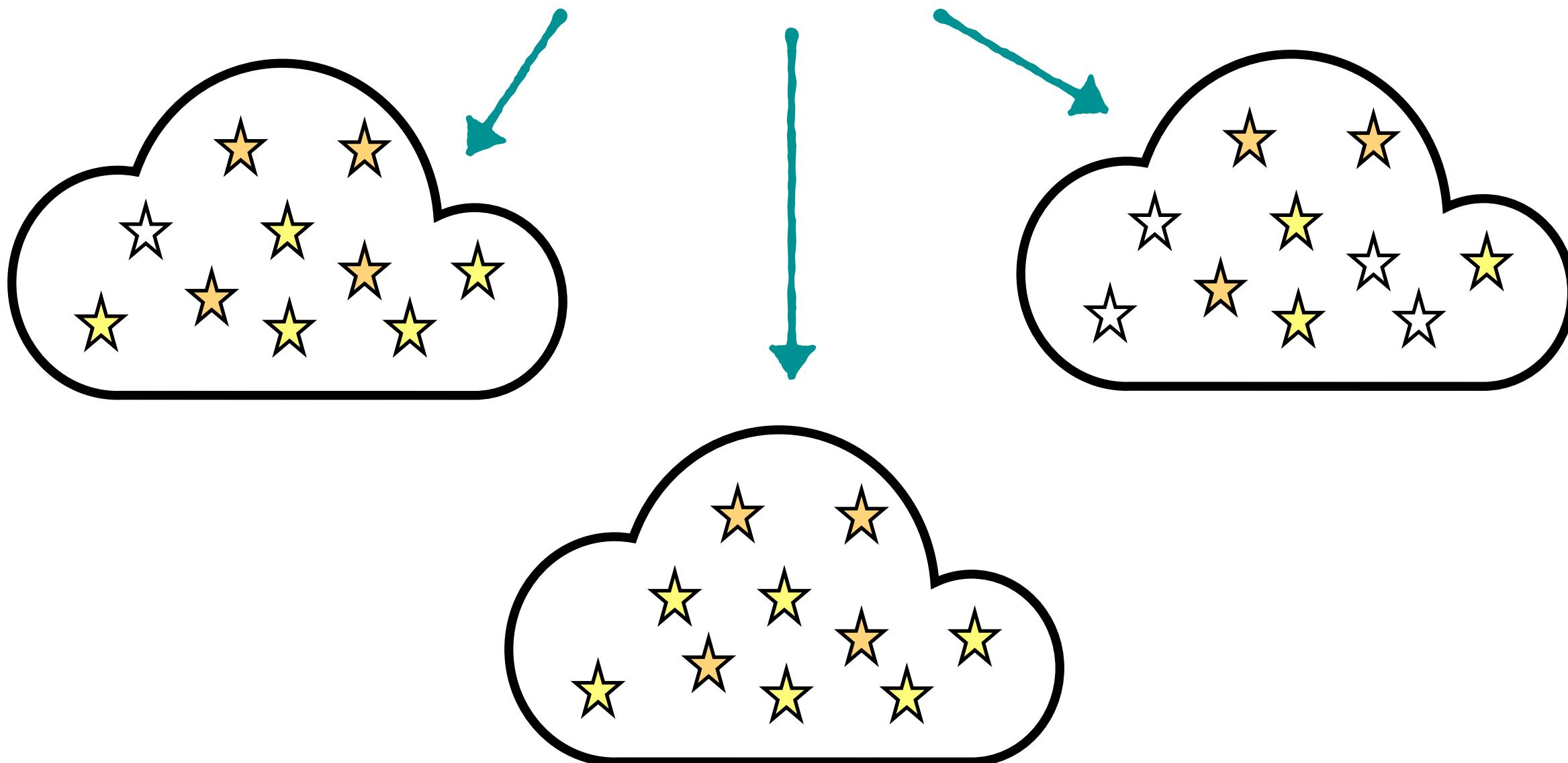
VETRARBRAUT

Massalitlar stjörnur lifa
lengur en aldur alheimsins!



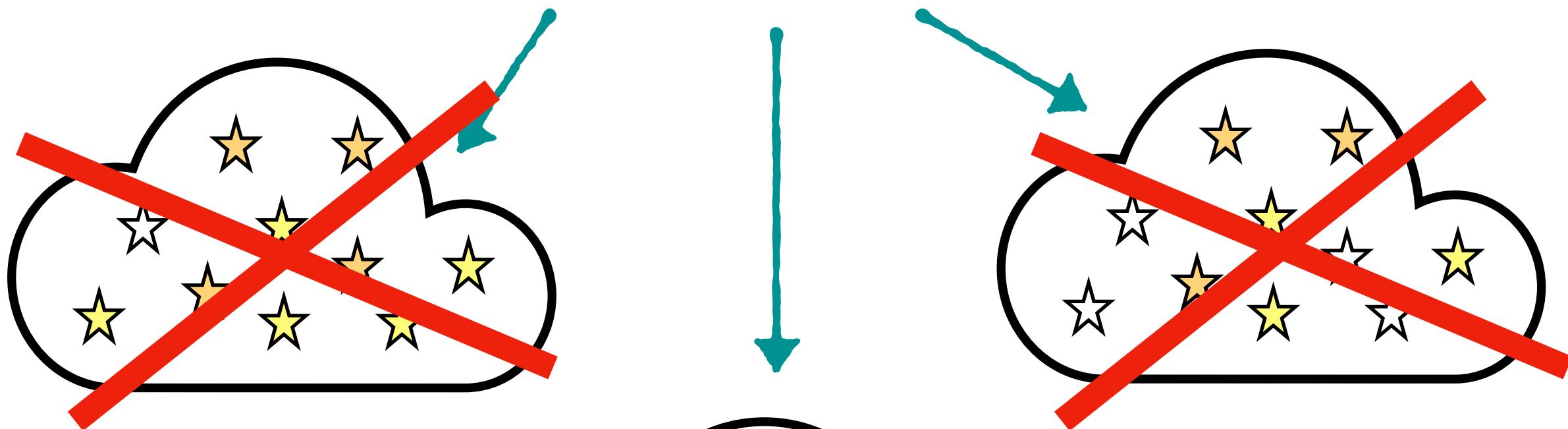
LÍKÖN AF MINNSTU DVERGVETRARBRAUTUNUM

Ef við gerum ráð fyrir mismunandi massadreifingu fyrstu stjarnanna



LÍKÖN AF MINNSTU DVERGVETRARBRAUTUNUM

Ef við gerum ráð fyrir mismunandi massadreifingu fyrstu stjarnanna

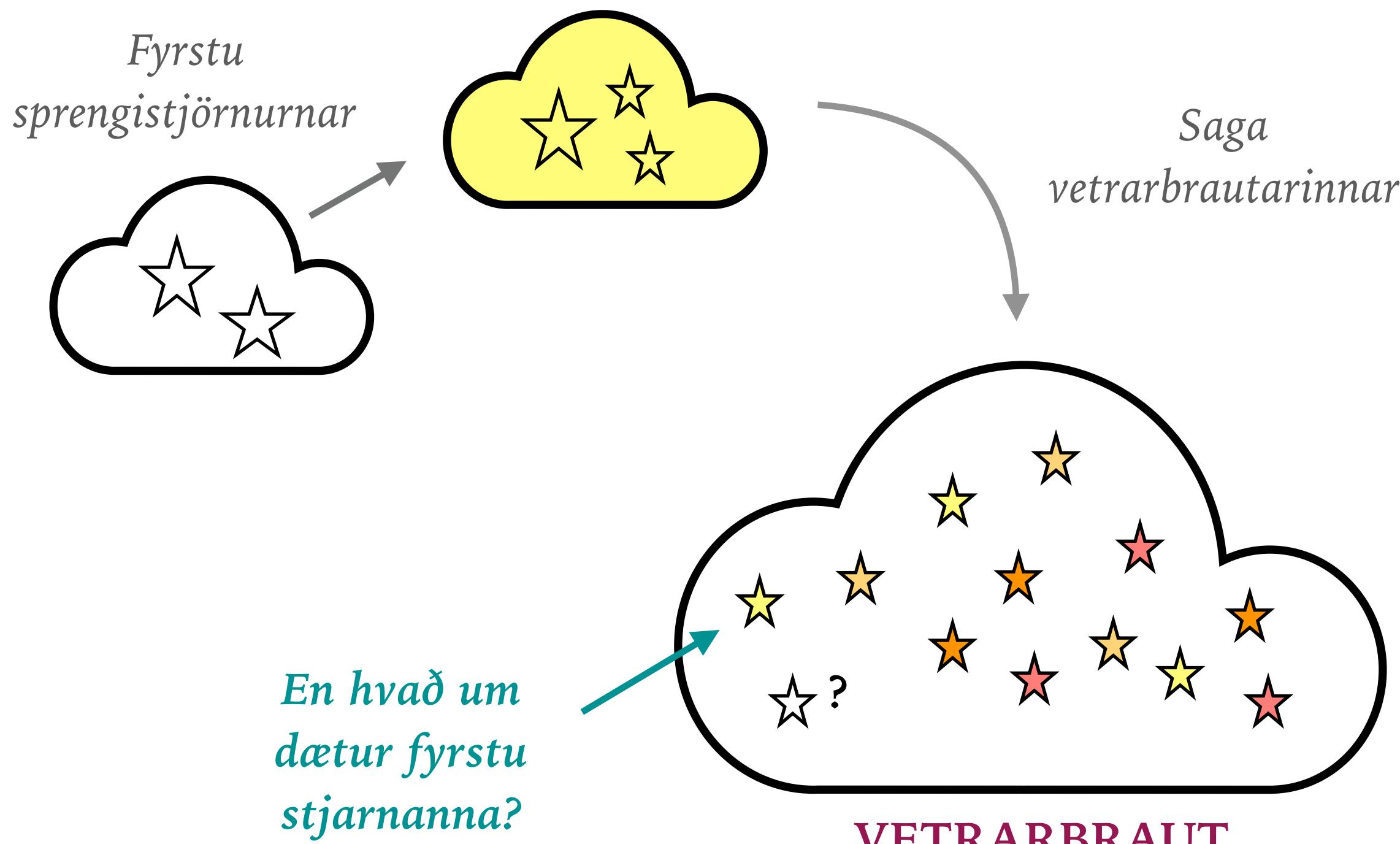


Fyrstu stjörnurnar voru massameiri en nútíma stjörnur!
(annars hefðum við fundið þær!)



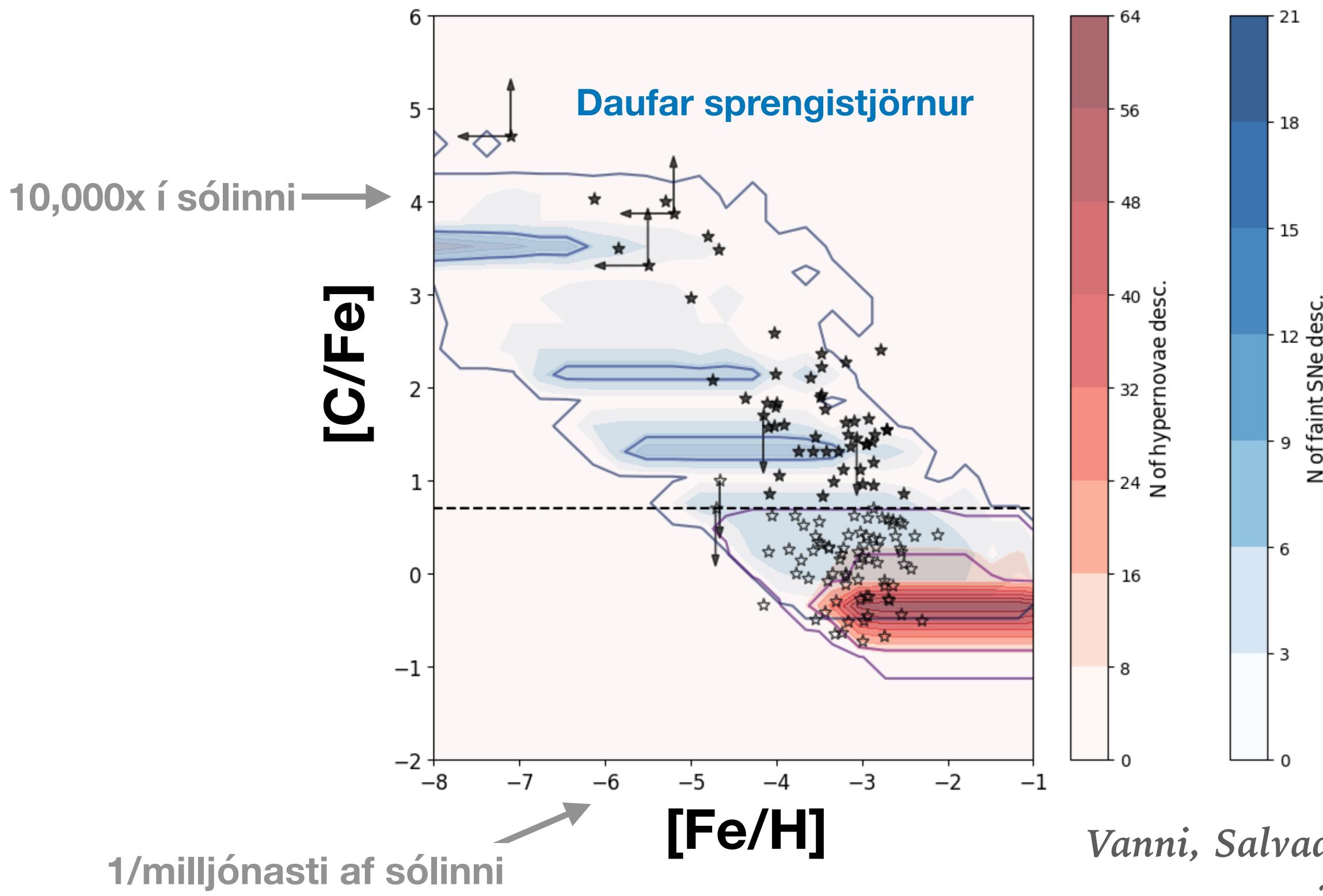
Við getum líka lært á því að finna ekki það sem við leitum að

NÆSTA KYNSLÓÐ STJARNA



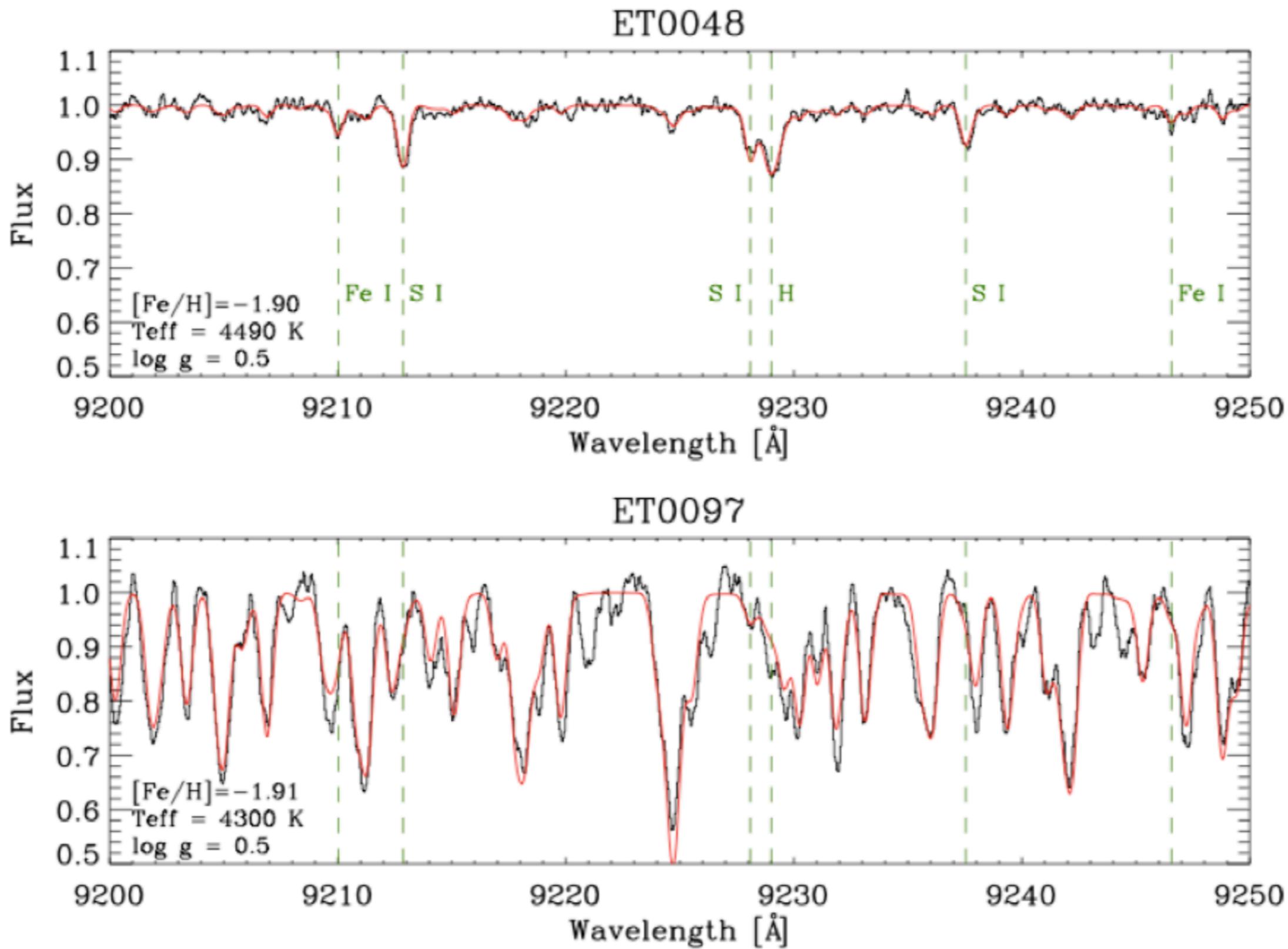
Massalitlar stjörnur lifa
lengur en aldur alheimsins!

KOLEFNISRÍKAR STJÖRNUR

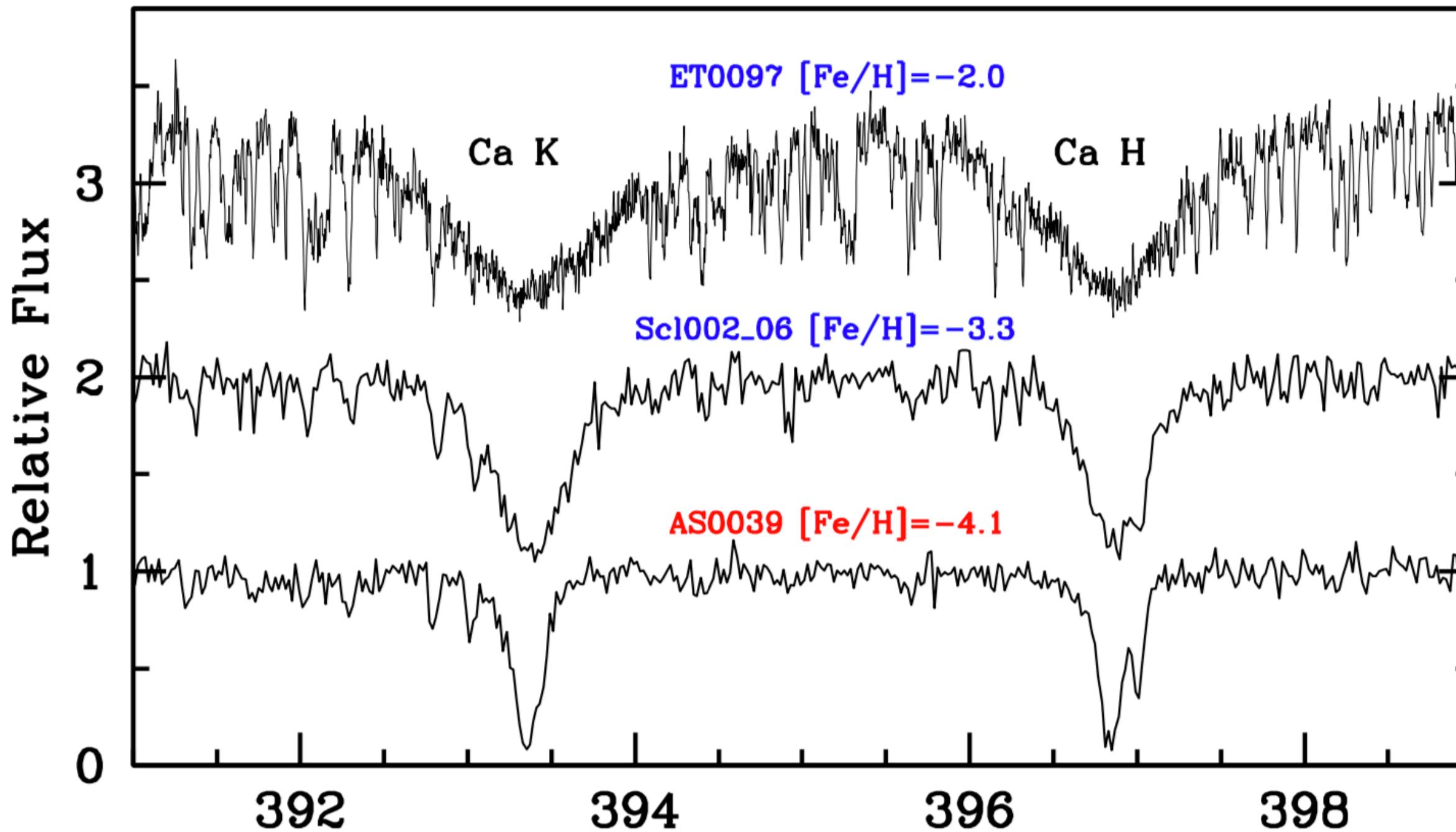


Vanni, Salvadori & Skúladóttir
2023

KOLEFNISRÍK STJARNA Í SCULPTOR!

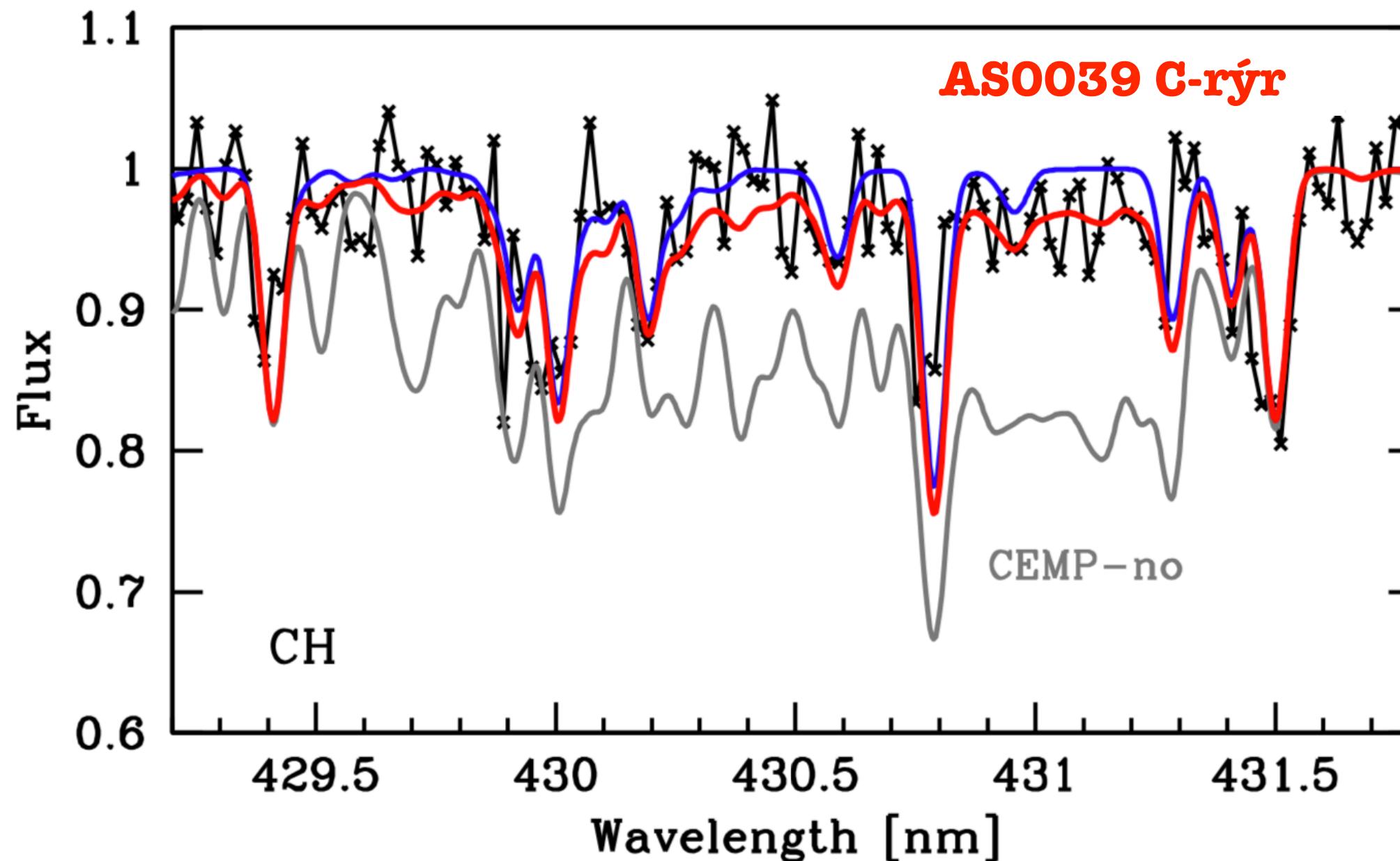


AS0039: [Fe/H]=-4



AS0039: KOLEFNISRÝR!

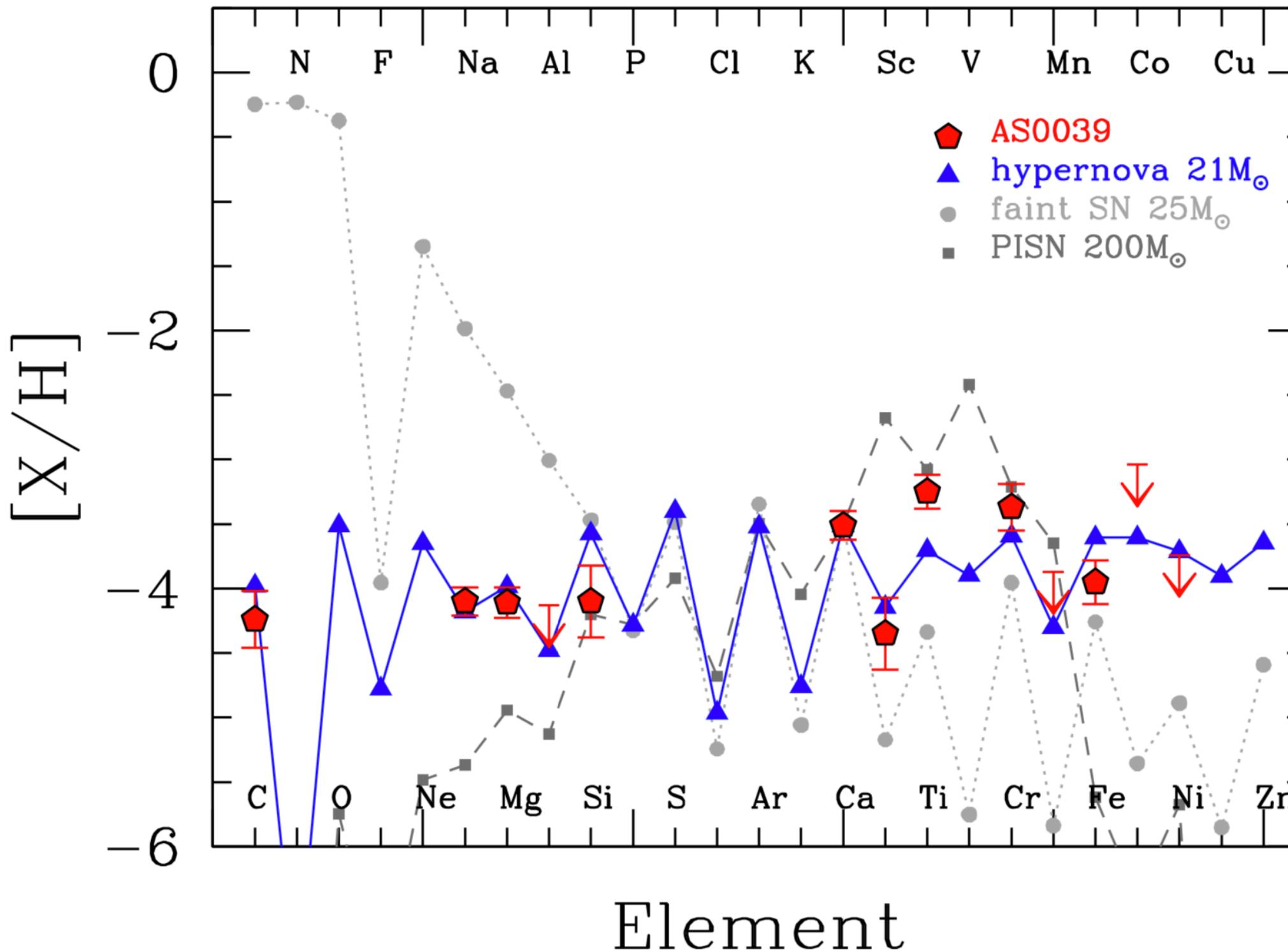
- Lægsta kolefnismagn sem hefur nokkur sinni verið mælt í stjörnu!
- Frumstæðasta stjarna sem hefur nokkurn tímann fundist í annarri vetrarbraut!



AFKOMANDI OFUR-SPRENGISTJÖRNU!

Skúladóttir et al. 2021

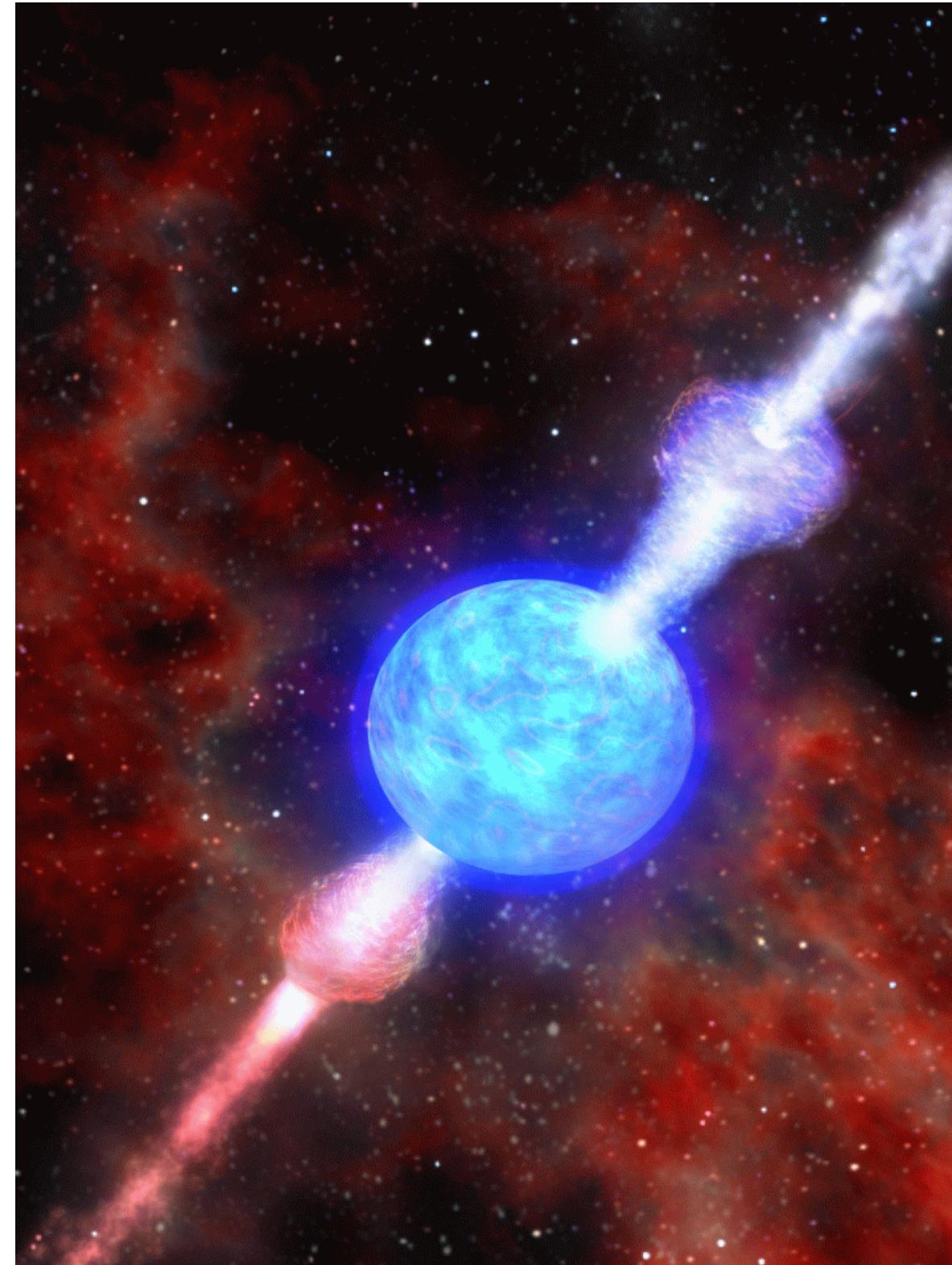
Yields: Heger & Woosley 2002; 2010, Iwamoto et al. 2005



AFKOMANDI OFUR-SPRENGISTJÖRNU!

Skúladóttir et al. 2021

Ofur-Sprengistjörnur
hafa um 10 sinnum
meiri orku en venjulegar
sprengistjörnur!



AFKOMANDI OFUR-SPRENGISTJÖRNU

Astronomers May Have Just Found Evidence of The Very First Stars in Our Universe

SPACE 19 October 2021 By MICHELLE STARR



The Sculptor dwarf spheroidal

New Evidence of the First Stars Could Reveal How Our Universe Switched On

Providing crucial clues to the 'first steps of the universe.'



Brad Bergan

Published: Oct 19, 2021 01:26 PM EST

LO STUDIO SU THE ASTROPHYSICAL JOURNAL LETTERS

Tracce d'una devastante supernova primordiale

Identificate le tracce chimiche dell'esplosione di un'antichissima supernova di grande energia in una stella di seconda generazione, denominata AS0039, presente nella galassia nana di Sculptor. Il risultato è frutto d'una ricerca guidata da due ricercatrici dell'Università di Firenze associate all'Istituto nazionale di astrofisica

 Ufficio stampa Inaf  29/07/2021

Nel profondo del tempo, quando l'universo era ancora bambino, circa 13,5 miliardi di anni fa, da un mare calmo e oscuro costituito solo da idrogeno ed elio apparvero le prime stelle. Si pensa che fossero stelle più massicce del nostro Sole, dunque destinate a morire esplodendo come supernove e diffondendo nell'ambiente circostante i primi elementi chimici pesanti forgiati durante la loro evoluzione: carbonio, ossigeno, ferro, zinco... La ricerca delle tracce delle prime stelle è ad oggi una delle frontiere più affascinanti dell'astrofisica e della cosmologia. Dal gas arricchito di elementi chimici derivanti dall'esplosione di quei primi astri sono infatti nate le stelle di seconda generazione. Di queste ultime, le stelle di piccola massa sono sopravvissute fino ai giorni nostri.



*La galassia nana dello Scultore (Sculptor dwarf galaxy).
Crediti: Eso/Digitized Sky Survey 2*

FYRSTU STJÖRNURNAR

*Næsta kynslóð
stjarna*

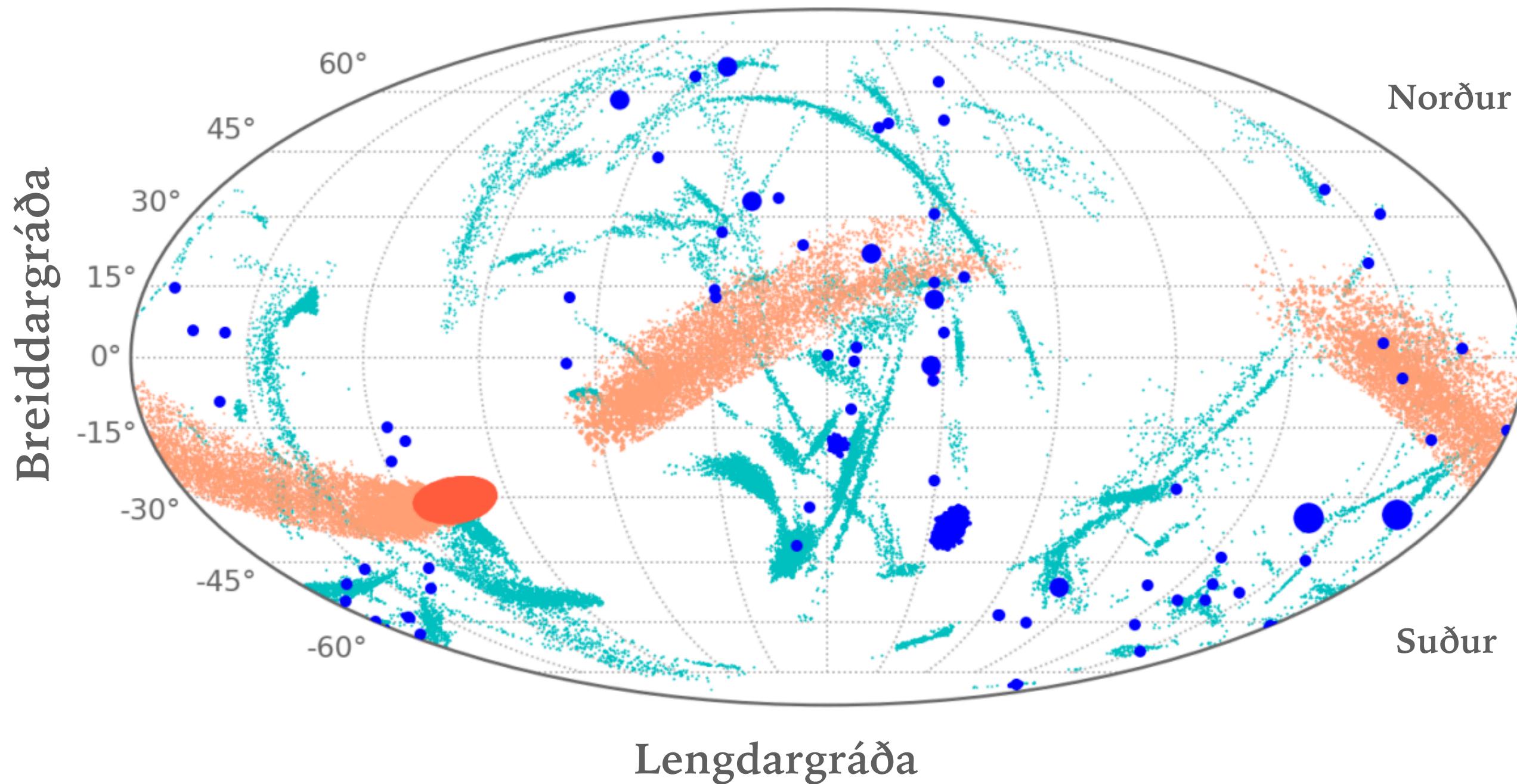
*Dætur fyrstu
stjarnanna?*



Vegferðin heldur
áfram!

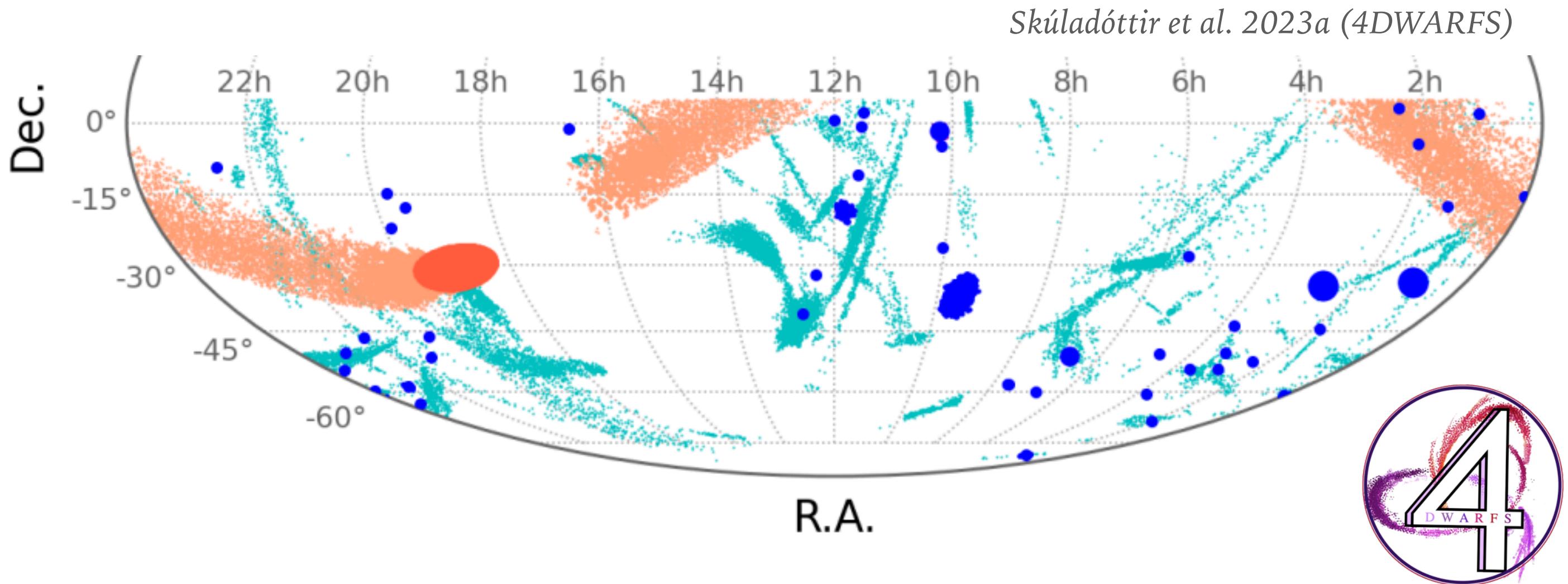
DVERGVETRARBRAUTIR

- Efnasamsetning stjarna - venjulega 1-100 stjörnur.



4DWARFS / 4DVERGAR

- 4DWARFS - 4MOST könnun um dvergvetrarbrautir og stjörnustrauma þeirra
- PI: Skúladóttir - 520 000 ljósleiðarclkukustundir.



4DWARFS / 4DVERGAR

ESO Public Spectroscopic Survey

Phase 1 LoI

4MOST survey of dwarf galaxies and their stellar streams (4DWARFS): Small but fundamental

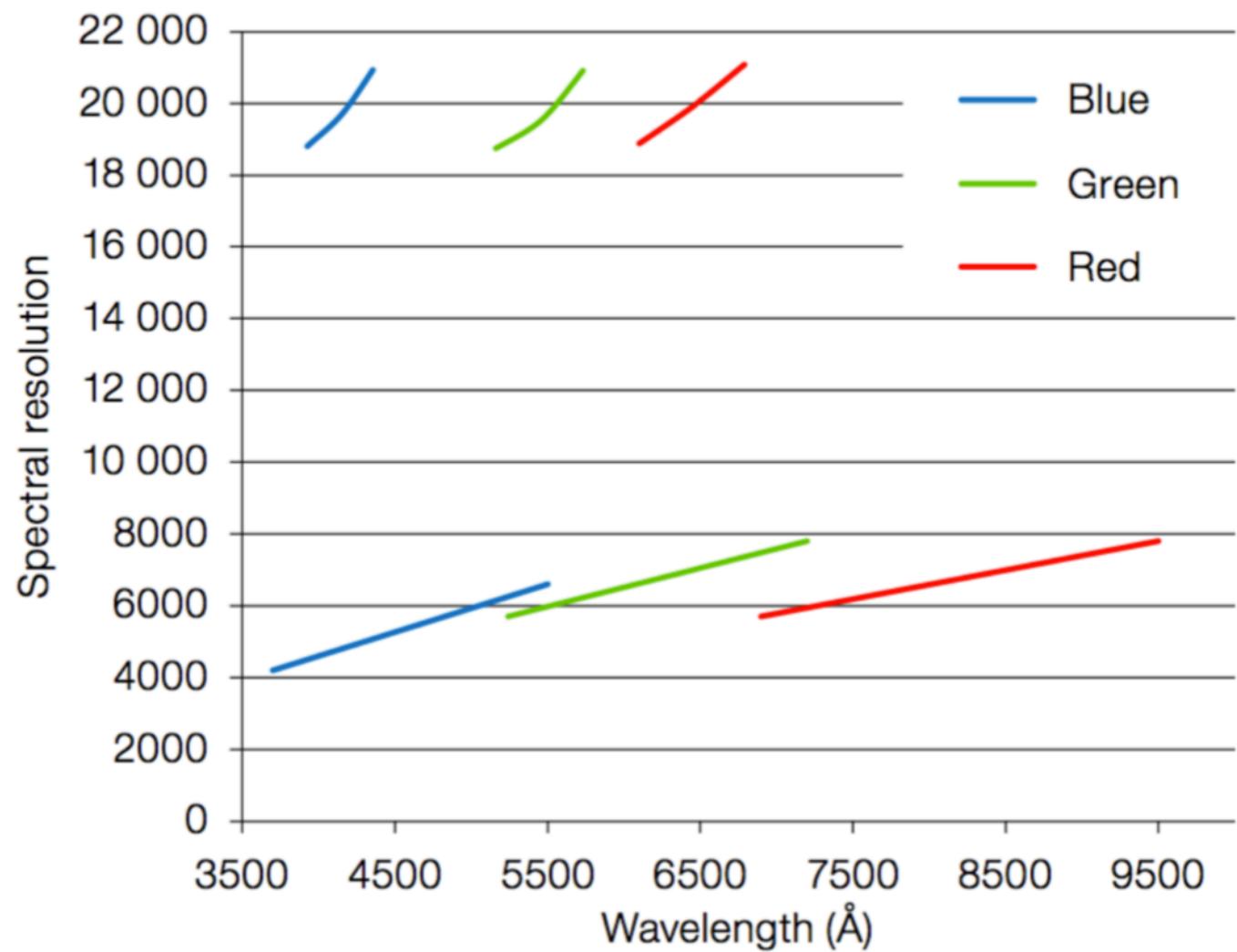
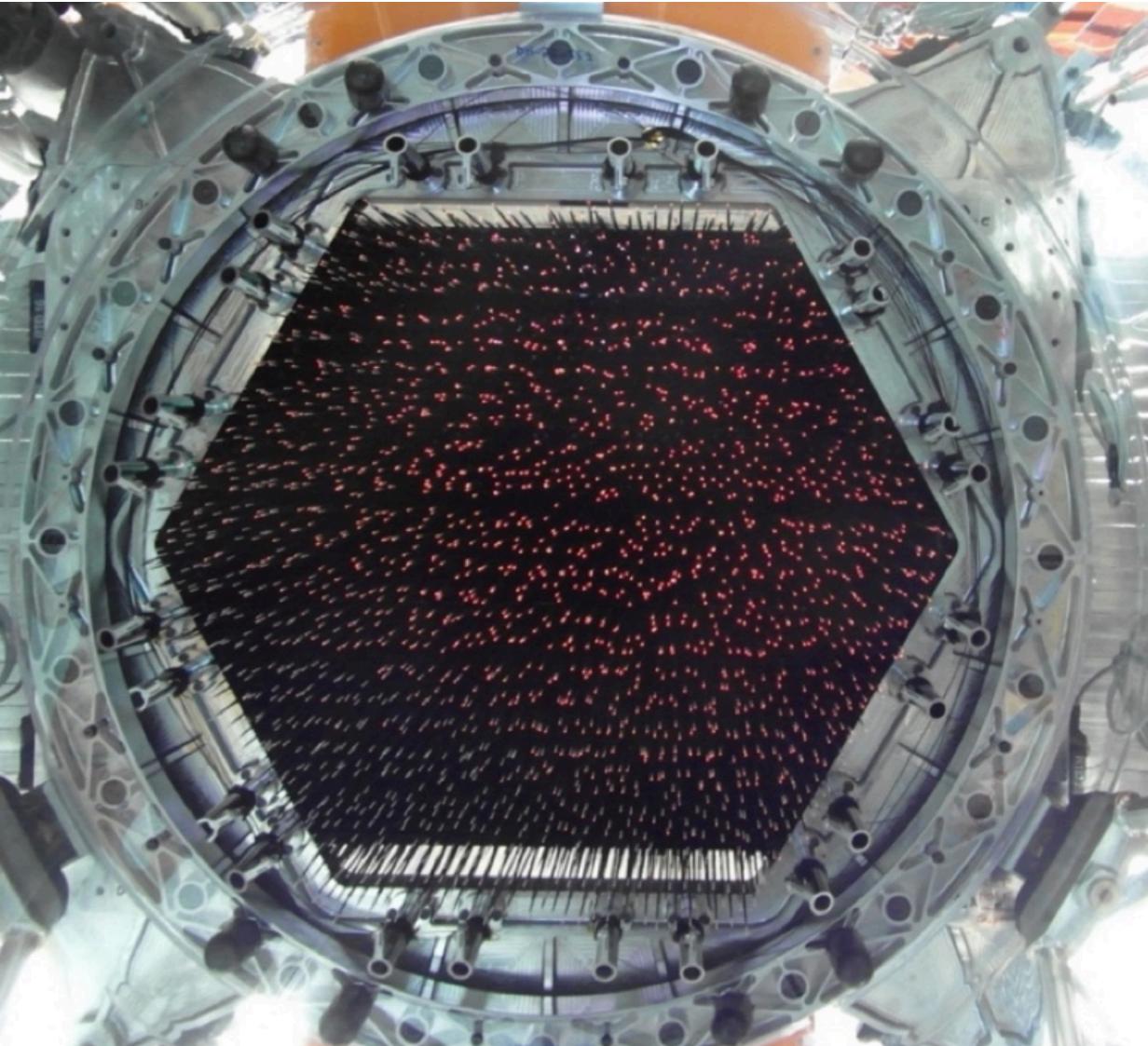
PI: Ása Skúladóttir [1,2] e-mail: asa.skuladottir@unifi.it

Cols: Anish M. Amarsi [3], Almudena Arcones [4,5], Giuseppina Battaglia [6,7], Sven Buder [8], Benoit Côté [9], Simon W. Campbell [10], Marius Eichler [4], Diane Feuillet [11], Andrew J. Gallagher [12], Viola Gelli [1,2], Melanie Hampel [10], Michael Hanke [13], Camilla J. Hansen [12], Sten Hasselquist [14,15], Vanessa Hill [16], Rodrigo Ibata [17], Nikolay Kacharov [12], Amanda Karakas [10], Andreas Koch [13], Karin Lind [18], Maria Lugaro [9], Davide Massari [19,20,21], Thomas Nordlander [8,22], Moritz Reichert [4], Martina Rossi [1,2], Ashley Ruitter [23], Stefania Salvadori [1,2], Ivo Seitenzahl [23], Eline Tolstoy [21], Theodora Xilaki-Dornbusch [24].

- Verðmæti gagnanna um ~400 milljónir íslenskra króna

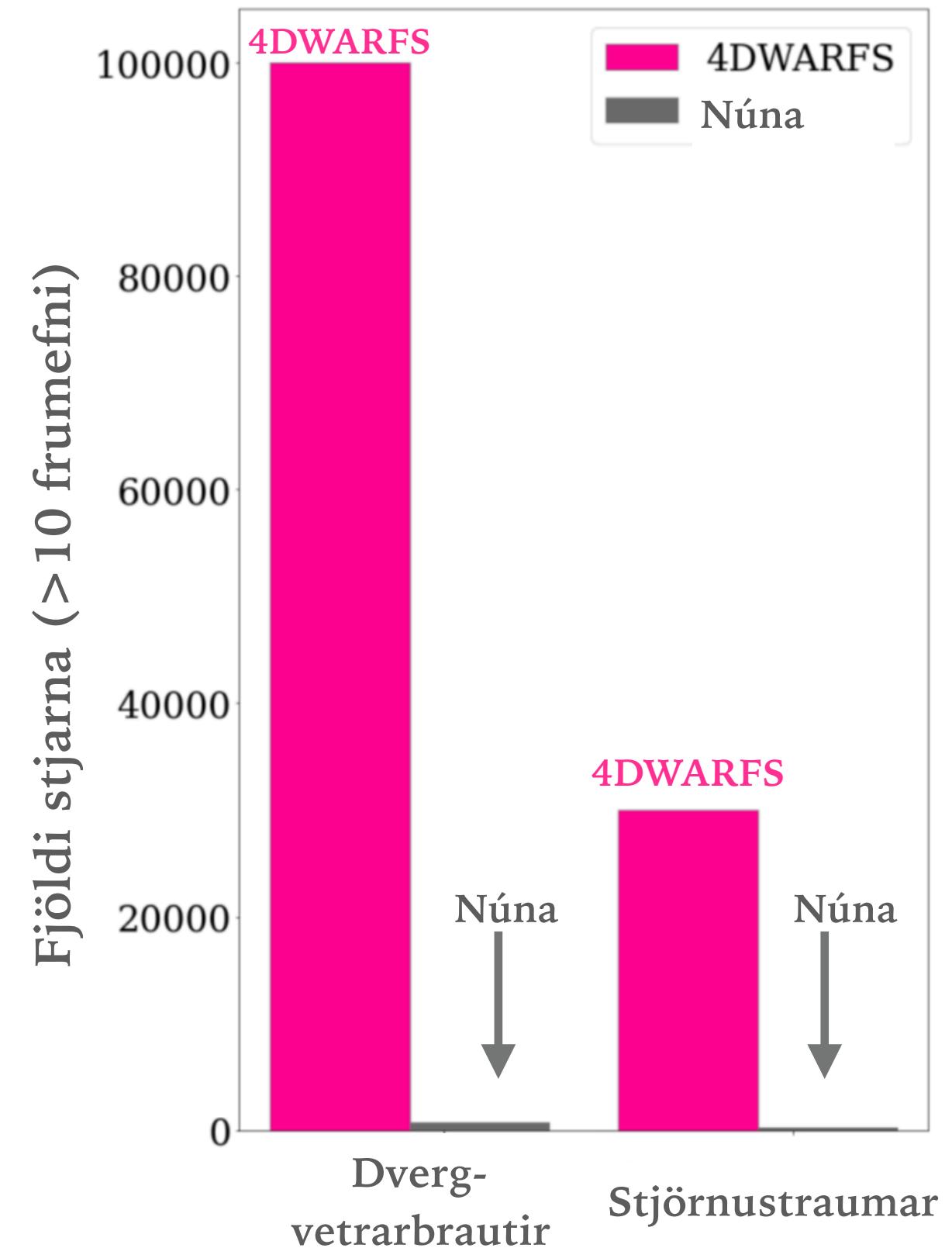
4MOST Á VISTA SJÓNAUKANUM

- Tekur 2400 litróf í einu!



4DWARFS

Efnasamsetning, hraði
og aldur stjarnanna.
Við ætlum að skrá sögu
dvergvetrarbrauta frá
upphafi til eyðileggingar.



4DWARFS: LYKILSPURNINGAR

Hverjir eru eiginleikar fyrstu stjarnanna?

Hvernig urðu frumefnin til og hver er saga
þeirra?

Hverjir eru hreyfifræðilegir eiginleikar
dvergvetrarbrauta?

Hvernig byggðust vetrarbrautir upp frá
smæstu dvergvetrarbrautunum?

LOKAORÐ!

- Dvergvetrarbrautir eru frábærar!
- Við erum að öðlast nýjan skilning á eðli fyrstu stjarnanna.
- Við lifum á gullöld stjarneðlisfræðinnar!



Logo eftir Martina Rossi