狭帯域金属欠乏星探査

冨永望

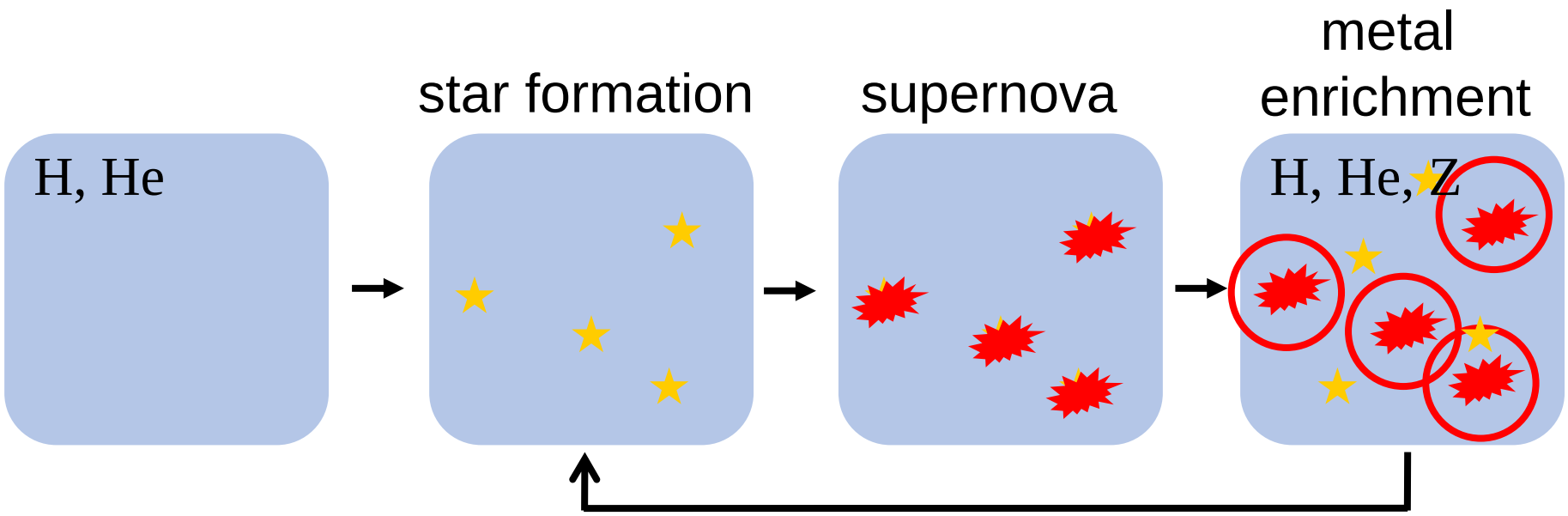
（国立天文台）

岡田寛子、本田敏志、古塚来未(兵庫県立大)、青木和光、金子慶子、岩下光、三ツ井健司、福田武夫、福嶋美津広、神澤富雄(国立天文台)、諸隈智貴(千葉工大)、高橋英則、酒向重行(東大)

Contents

- Metal-poor stars
- 2022年9月 試験観測
- Gaia DR3について

Metal-poor stars



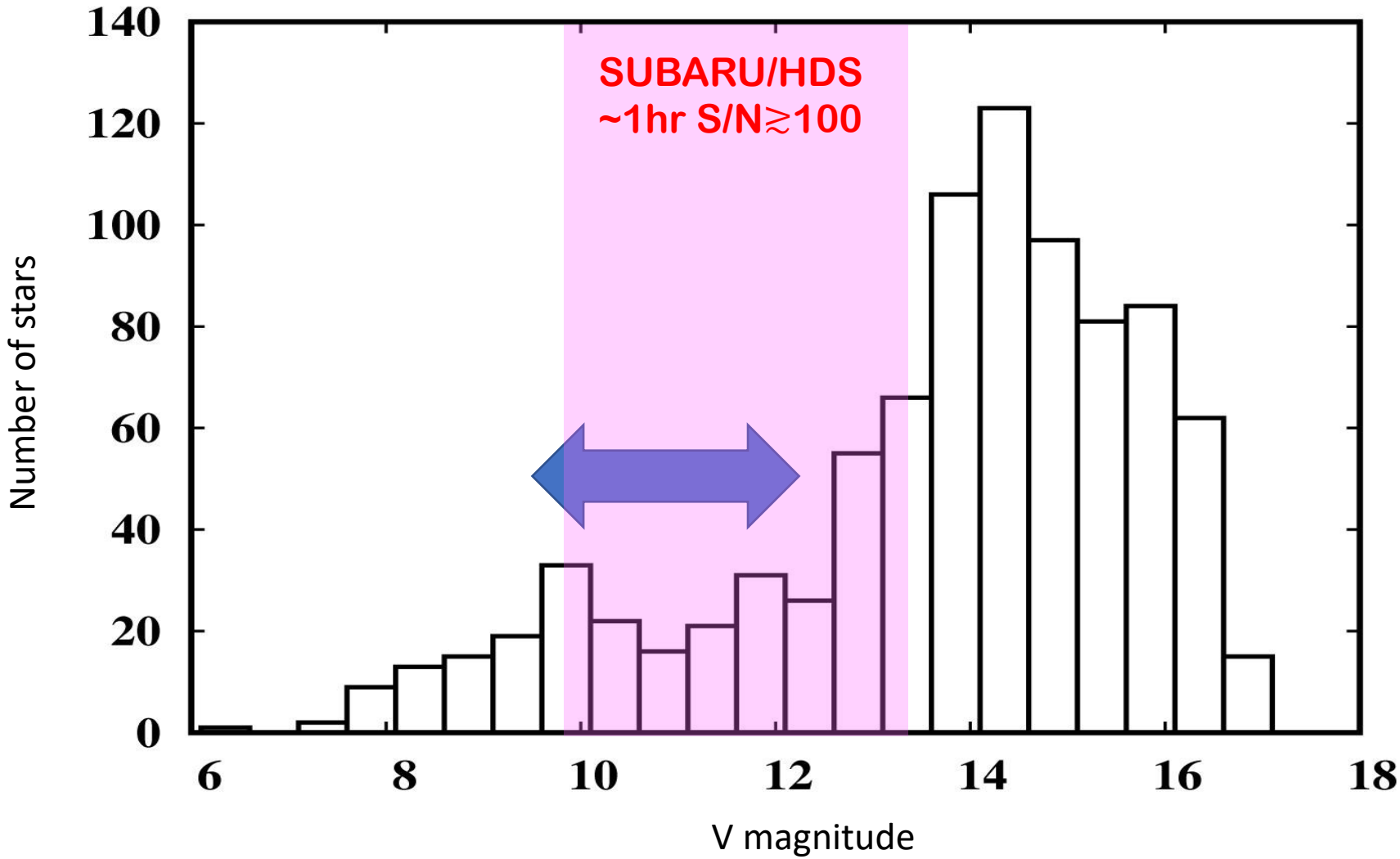
Metallicity increases with time

$[Fe/H] = \log(Fe/H) - \log(Fe/H)_{\odot}$

What we can learn from MP stars

- Origin of elements
- First supernovae
- First stars
- Chemical evolution
- Galaxy formation

Number of metal-poor stars with [Fe/H]<-2



基盤研究A（2021～2024年度）

明るい金属欠乏星の全北天域探査による初代星元素合成と初期銀河系形成の解明

「北半球から観測可能な明るい金属欠乏星を網羅的に探査」

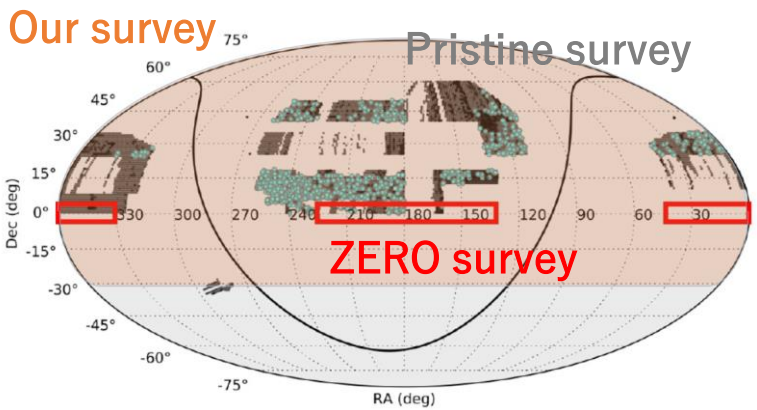


図2

- 研究代表者：青木和光
- 研究分担者：冨永望、本田敏志、諸隈智貴、石垣美歩、平居悠、須田拓馬、野本憲一
- 研究協力者：千秋元、小笹隆司、松野允郁

観測研究1
明るい金属欠乏星探査・分光観測
諸隈、冨永、本田

観測研究2
金属欠乏星データベース構築
データ系統解析
青木、石垣、須田（松野）

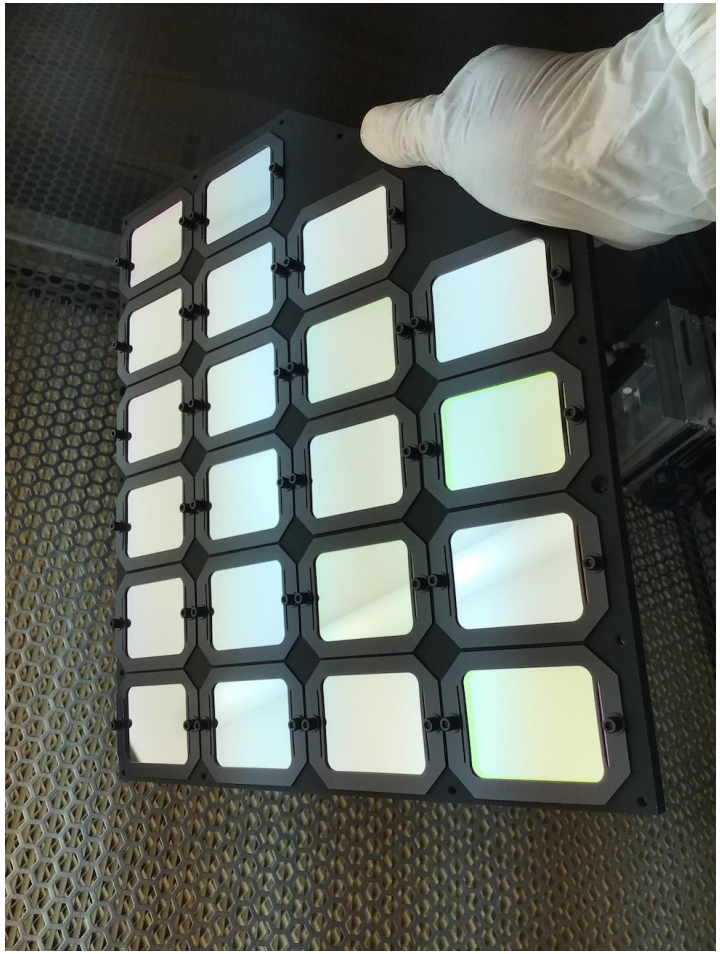
星の動力学(Gaia)

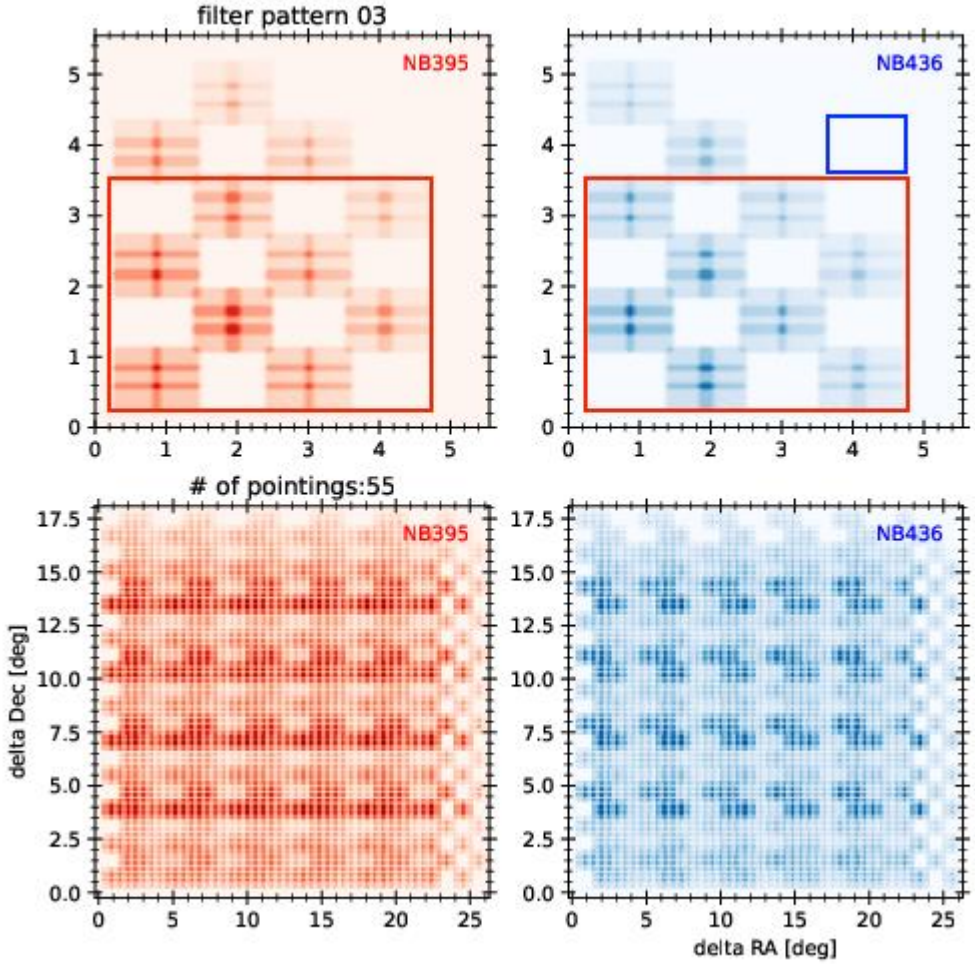
初代星の元素合成と次世代星・銀河形成の解明

理論研究1
初代星の進化と超新星元素合成
冨永、野本、石垣

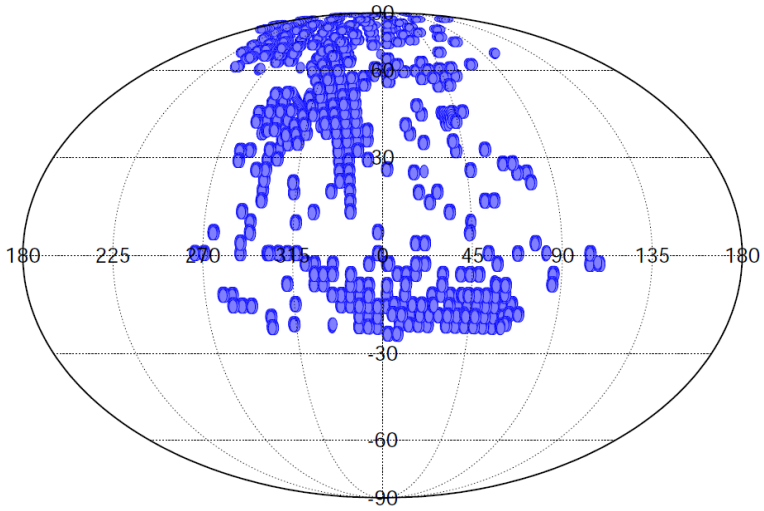
理論研究2
初代星放出物質からの次世代星形成
平居、冨永（千秋、小笹）

Filter config. & dithering pattern





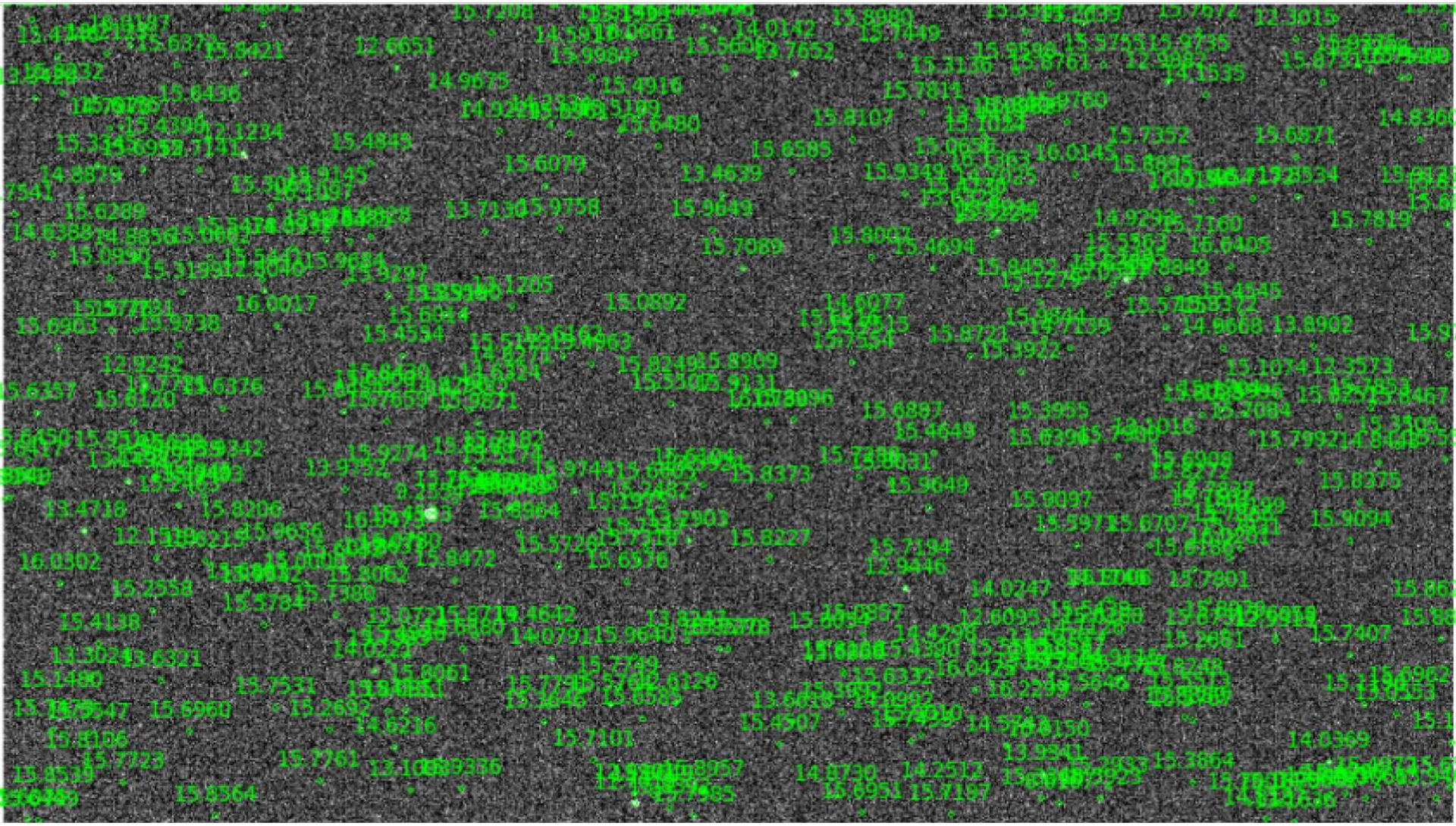
試験観測



- 9/8-10/5
  - 晴れ3晩
  - Number of fits (incl. calib. data): 109,908
  - Astrometry
    - Succeeded: 87,091 (NB395 41821, NB433 46015)
    - Failed: 22,817 (NB395 15859, NB433 7150)
  - Independent fields: 358 (x15deg2)
  - Number of stars (のべ数): ~13,700,000
  - Number of stars (<12mag): ~530,000

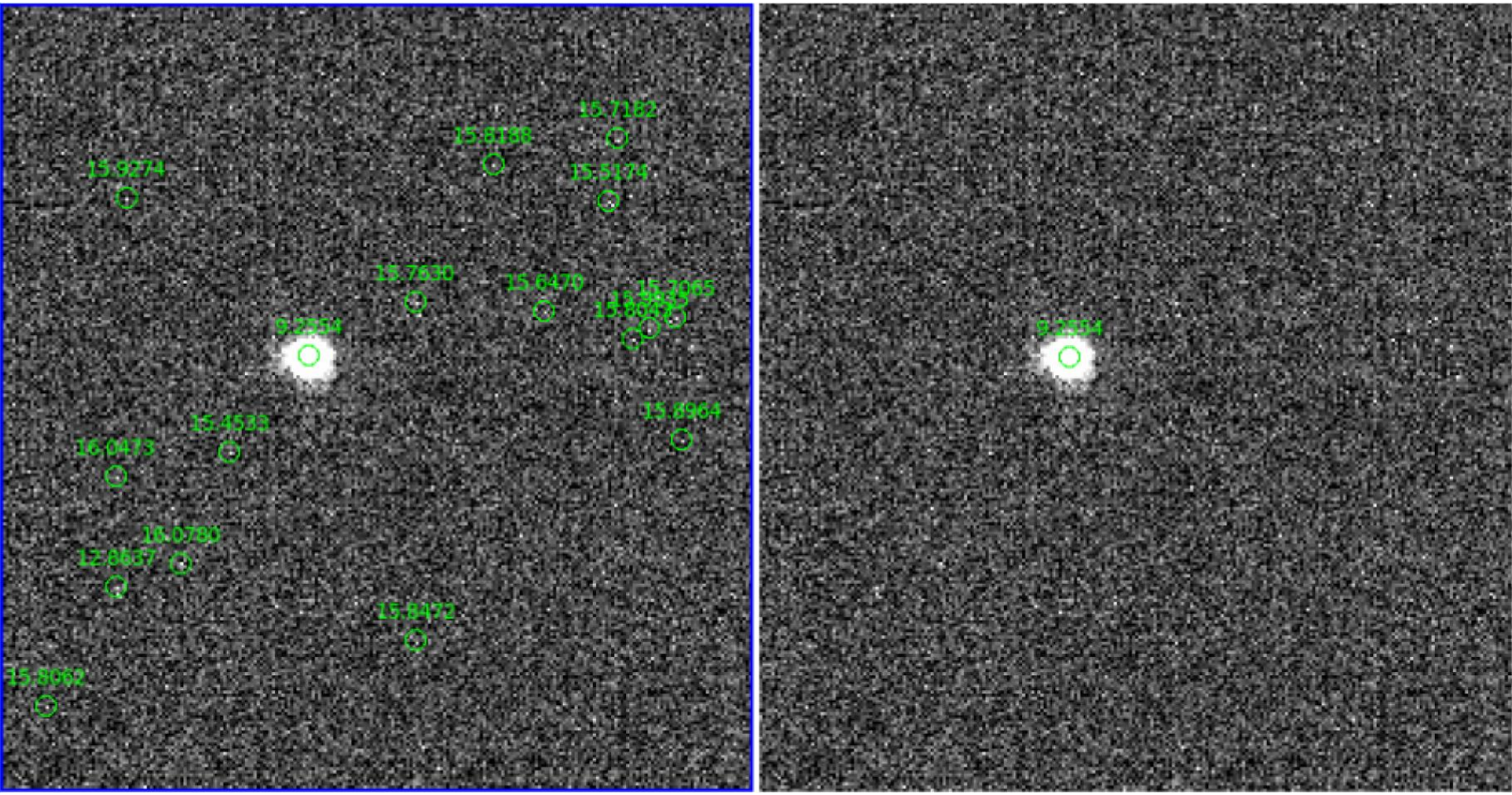
Image

NB395
BGCOUNT = 1.00 (NB433 4.34)
BGMEDIAN= 0.96 (NB433 4.38)
BGSTDDEV= 9.04 (/0.5s exp) -> 1.65 (/15s exp)

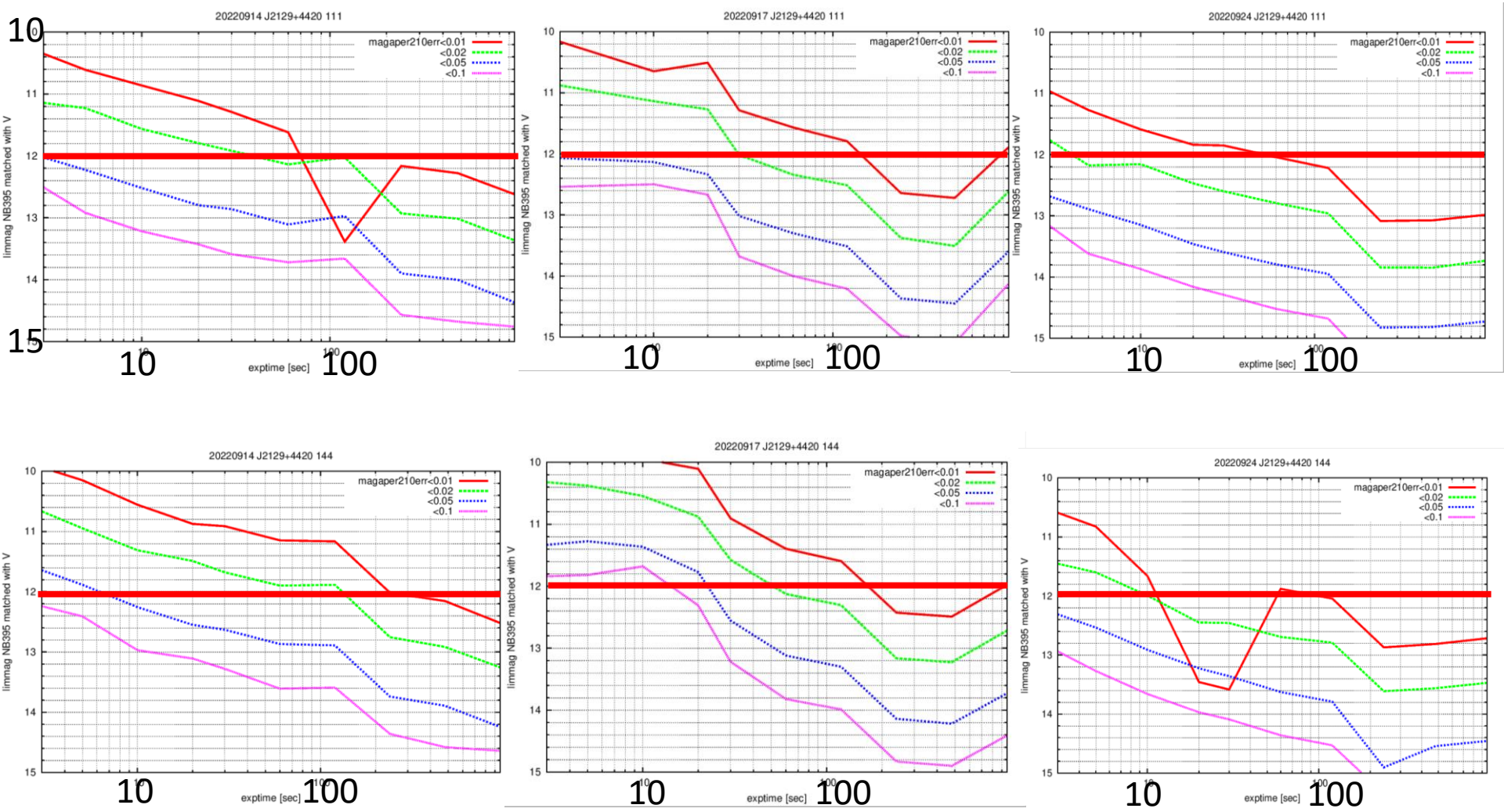


Hot pixels?

- Mask made with 1000 exposures



Depth

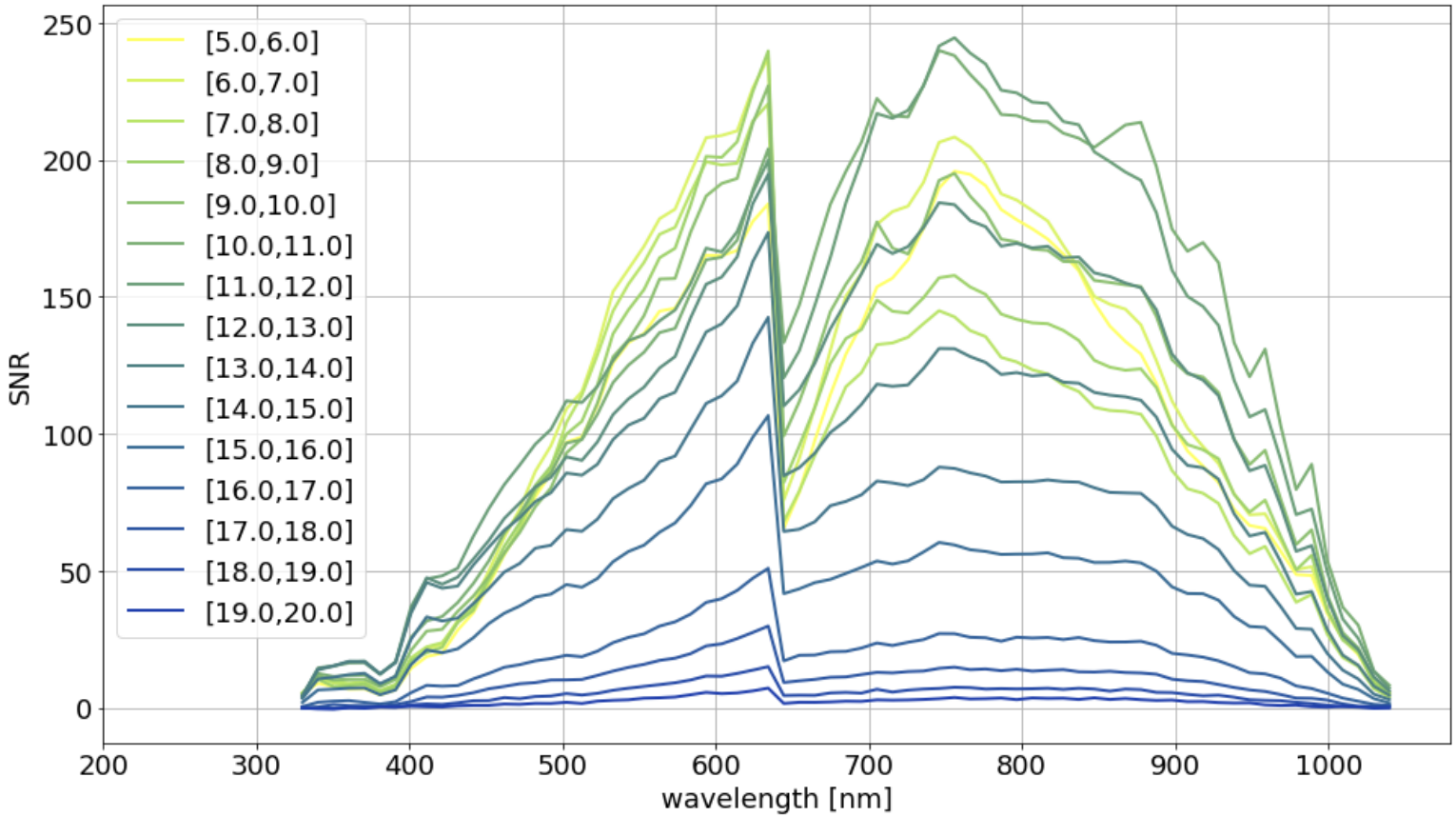


- 15 sec exposure (0.5s x 30) is adopted.

Gaia DR3 (Jun 2022)

- Astrophysical parameters (Teff, logg, [M/H], AG, distance, etc.) from BP/RP spectra for 470 million objects
- Astrophysical parameters (Teff, logg, [M/H], [X/M] for 12 elements, etc.) from RVS spectra for 5.5 million objects
- Mean BP/RP spectra for 219 million sources, most of them with G < 17.6 mag
- Mean RVS spectra for 1 million well-behaved objects

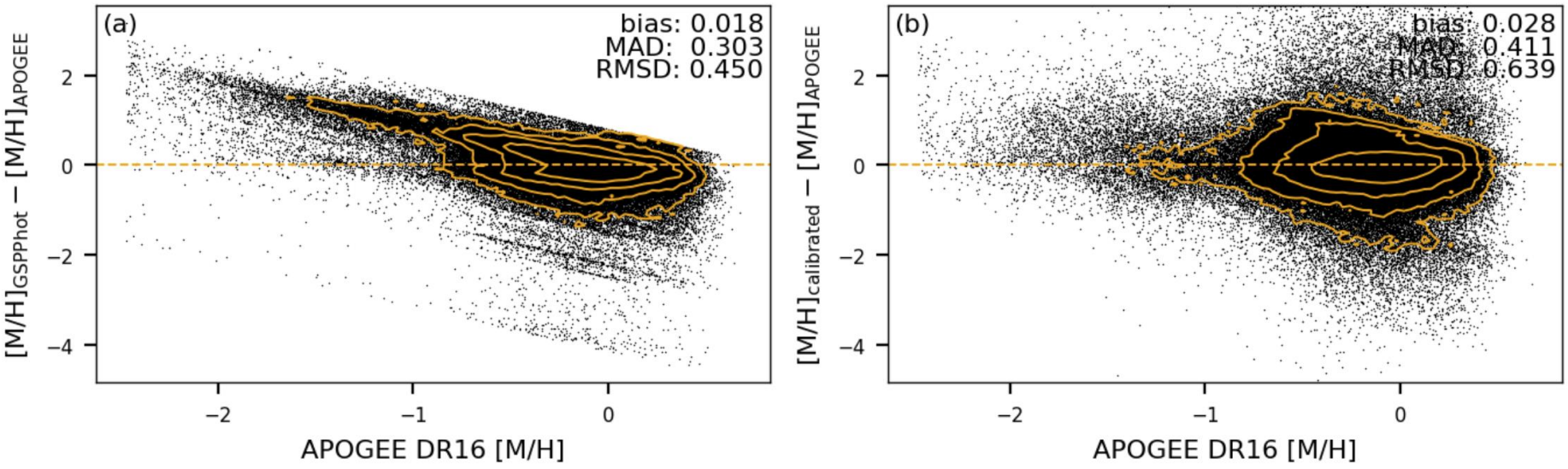
Gaia DR3 BP/RP Mean Spectra



Metallicity estimates exhibit substantial biases compared to literature values and are only useful at a qualitative level. However, we provide an empirical calibration of our metallicity estimates that largely removes these biases.

Andrae+22

Metallicity estimate with BP/RP spectra



Metallicity estimates from GSP-Phot are generally very poor, being ~0.1 dex too low and exhibiting additional strong systematics. Therefore, we do not recommend to use the [M/H] estimates from GSP-Phot. However, GSP-Phot [M/H] estimates can be calibrated empirically, e.g. using LAMOST data.

https://gea.esac.esa.int/archive/documentation/GDR3/Data_analysis/chap_cu8par/sec_cu8par_apsis/ssec_cu8par_apsis_gspphot.html

Works with Gaia data

Recovering the very metal-poor stars in the Gaia DR3 GSP-Spec catalog

Tadafumi Matsuno[1], Else Starkenburg[1], Eduardo Balbinot[1], and Amina Helmi[1]

Only 23% of VMP stars have a metallicity dierent by more than 0.5 dex from a high-resolution value.

Robust Data-driven Metallicities for 175 Million Stars from Gaia XP Spectra

René Andrae,[1] Hans-Walter Rix,[1] and Vedant Chandra[2]

A catalog of over 17 million bright (G < 16) red giants whose [M/H] are vetted to be precise and pure

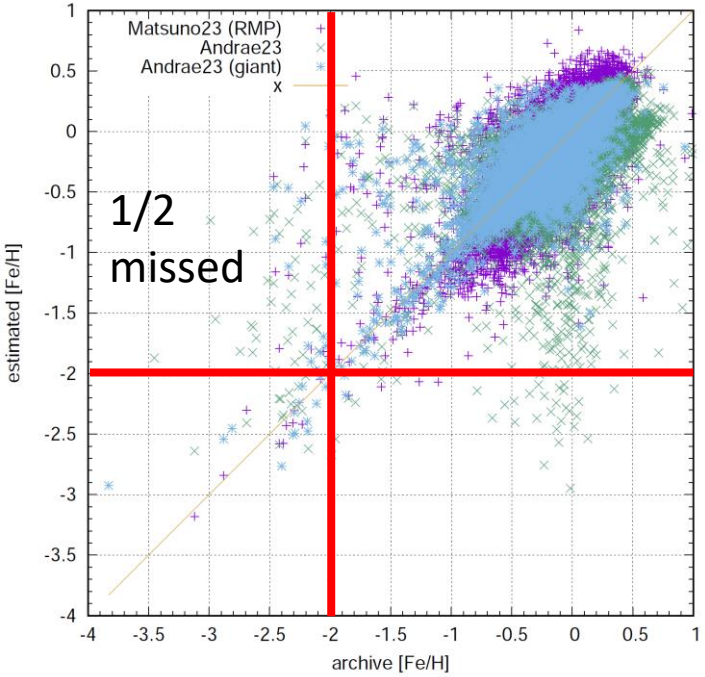
188,000 Candidate Very Metal-poor Stars in Gaia DR3 XP Spectra

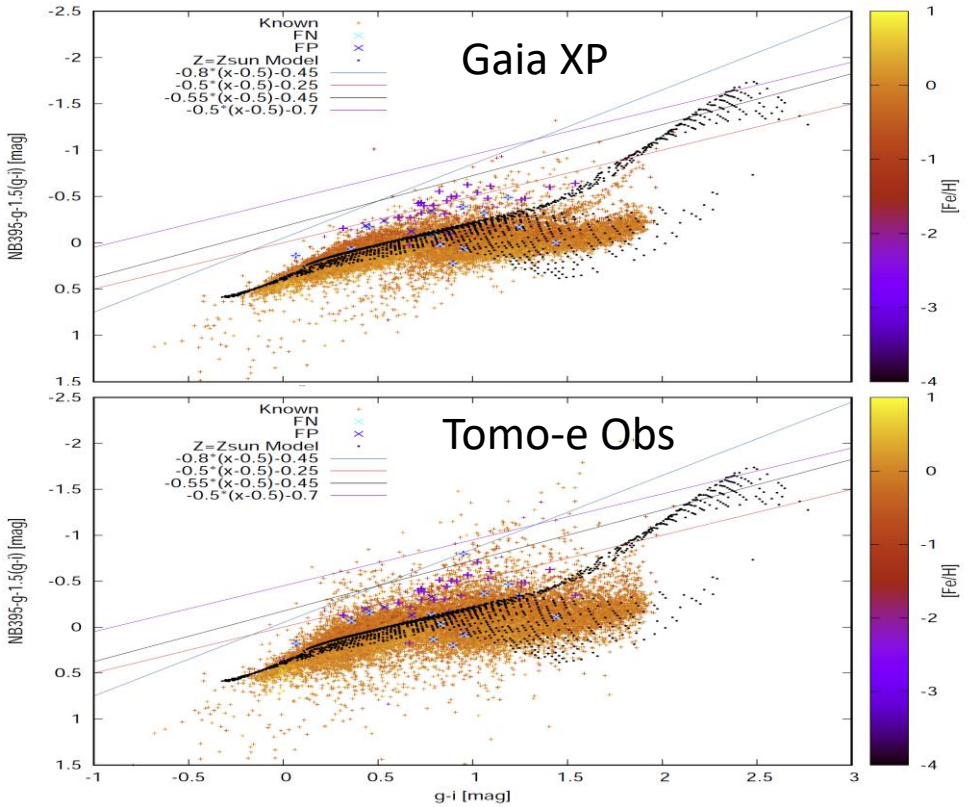
Yupeng Yao (姚宇鹏),[1] Alexander P. Ji,[1,2] Sergey E. Koposov,[3,4,5] Guilherme Limberg[1,2,6]

They are classifier-T (for Turn-off stars), classifier-GC (for Giant stars with high completeness), and classifier-GP (for Giant stars with high purity) with expected purity of 47%/47%/74% and completeness of 40%/94%/65% respectively (BP<16).

Summary of and comparison with Gaia

- GaiaDR3全体 (G<12): 3,087,821
  - Gaia XP: 2,871,322
  - Matsuno+23: RMP 1,926,448 (1/3 missed)
  - Andrae+23: giant 1,230,309 (2/3 missed)





まとめ

- 2022/9/8 – 2022/10/5 試験観測
  - 晴れ3晩
  - ~15sec exposure (0.5s x 30)
  - ~ 5000 deg2
  - ~ 530,000 stars (G<12) observed
  - 追観測の詳細は岡田さん講演

- 今後どうするか?
  - Gaiaよりよいことができるか?