last update: June 17, 2020 (click here for the live version)

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# Personal information

Full name Vinicius Moris Placco

Nationality Brazilian and Italian; US permanent resident

Languages Portuguese (native), English (fluent),

Spanish (intermediate), Italian (basic)

Address 5621 Town Center Drive, ap 13

Granger, IN 46530 - USA

Phone +1 (520) 468-8215 Website http://vmplacco.github.io/

e-mail vmplacco@gmail.com

# **Employment / Appointments**

2015- Research Assistant Professor

Department of Physics University of Notre Dame

2018– Faculty Fellow

Liu Institute for Asia and Asian Studies

University of Notre Dame

2014-2015 Science Fellow

Gemini Observatory – Northern Operations Center Association of Universities for Research in Astronomy

2013-2014 Postdoctoral Fellow

National Optical Astronomy Observatory

Association of Universities for Research in Astronomy

2010-2013 Postdoctoral Fellow

Instituto de Astronomia, Geofísica e Ciências Atmosféricas

Universidade de São Paulo

### Education

2007–2010 Doctorate degree in Astronomy

Search for very metal-poor stars based on carbon over-abundance

Instituto de Astronomia, Geofísica e Ciências Atmosféricas

Universidade de São Paulo

2005–2007 Master's degree in Astronomy

Abundance patterns among very metal-poor stars in the Galaxy: a statistical approach

Instituto de Astronomia, Geofísica e Ciências Atmosféricas

Universidade de São Paulo

2001–2005 Bachelor's degree in Physics (concentration: Astronomy)

Instituto de Física

Universidade de São Paulo

### **Awards**

2011 Featured Astronomy thesis of the year 2010

Instituto de Astronomia, Geofísica e Ciências Atmosféricas

Universidade de São Paulo

2005 Best Astronomy undergraduate project

Instituto de Astronomia, Geofísica e Ciências Atmosféricas

Universidade de São Paulo

# **Observatory Experience**

# Leardership roles/Service

2018-present 2017-present 2017-present	sent Member of the S-PLUS Advisory Committee (Southern Photometric Local Universe Survey)				
2020-present 2019-present 2018-present 2017-present 2017-present 2017-present 2018-present 2018-					
2018-present 2018-present 2018-present 2017-present 2018-2019 2017-2018	Co-coordinator of the Resolved Stellar Population Working Group of the J-PAS Survey Member of the US Extremely Large Telescope Program – First Stars Key Science Project Member of the Maunakea Spectroscopic Explorer (MSE) Science Team Co-coordinator of the Stellar Parameters Value-Added Catalog Group of the J-PLUS Survey Member of the NOAO Time Allocation Committee - Galactic Panel 2 Member of the Gemini OCS Upgrades Working Group				
2017-2018	Member of the Gemini OCS Opgrades Working Group				

# Operations and Instrument/User Support

2014–2015 **Gemini-North**: Operations

Support Scientist for Phase II programs Backup support for instrument teams

Interface between observatory and visitors (staff, scientists, and others) Interactions with astronomers, engineers, IT personnel, and facilities staff

Community support (help-desk and troubleshooting) Write/edit/update internal and external webpages

Weekly operations meetings

Queue observer Data reductions

2014–2015 **Gemini-North**: GMOS Instrument Team

Instrument performance monitoring pipeline

Throughput characterization
Commissioning of AO capabilities

Write/edit/update internal and external instrument webpages

Data quality assessment

Commissioning of Hamamatsu CCD at GMOS-S

2014–2015 Gemini-North: GRACES Instrument Team

Commissioning of the instrument Developed early data-reduction pipeline

Write/edit/update internal and external instrument webpages Developed exposure time calculator (GRACES ITC v0.1 Beta)

2008–2012 **SOAR Telescope**: remote observing station – University of São Paulo

Responsible for operations and maintenance

Develop data reduction tools

Edit/write manuals and data analysis cookbooks

User support and troubleshooting

Configure, quote, and purchase new workstations and teleconference hardware

Work with university staff and IT personel to ensure physical access to buildings and computers

Support daytime calibrations / nighttime observations

# Observing Experience

Period	Telescope	# of nights	instrument	mode
2019-present	CTIO/Blanco	5	COSMOS	remote
2011-present	ESO/NTT	12	EFOSC2	visitor
2008-present	SOAR	40+	Goodman OSIRIS	remote
2013–2018	KPNO/Mayall	20+	RCSPEC KOSMOS	visitor/remote
2014–2015	Gemini North	12	GMOS GRACES GNIRS NIRI NIFS	queue observer
2014–2015	Gemini South	2	GMOS	remote
2013	McDonald 2.1m	4	ES2 Spectrometer	visitor

# Research Experience

# **Funding**

#### Current

2018–2020 Hubble Space Telescope (Co-PI)

The Unexplored Domains of the s-Process

Space Telescope Science Institute (USD 119,104)

2019–2021 Hubble Space Telescope (Co-PI)

HD 222925: A unique opportunity to study the full range of nuclei produced by a single r-process event

Space Telescope Science Institute (USD 60,732)

2020–2022 Hubble Space Telescope (Co-I)

Testing r-process nucleosynthesis models with two r-process enhanced stars

Space Telescope Science Institute (USD 35,000)

#### **Pending**

2020–2023 Hubble Space Telescope (PI)

Observing Proposal for Cycle 28

Space Telescope Science Institute (Budget TBD)

2020-2023 NSF - Division of Astronomical Sciences (PI)

Astronomy and Astrophysics Research Grant

National Science Foundation (USD 320,618)

## Past (Total: USD 255,393)

2018 Liu Institute for Asia & Asian Studies (PI)

Stellar Archaeology as a Time Machine to the First Stars

University of Notre Dame (USD 600 - Travel support for conference)

2018 Liu Institute for Asia & Asian Studies (PI)

TDLI Workshop on The Exploding Universe

University of Notre Dame (USD 2,600 - Travel support for conference)

2015–2017 Hubble Space Telescope (Co-I)

The First Detections of Phosphorus, Sulphur, and Zinc in a Bona-Fide Second-Generation Star

Space Telescope Science Institute (USD 85,293)

2016–2017 Faculty Research Support Program Initiation Grant (PI)

Identification of CEMP Stars from S-PLUS Photometry using Artificial Neural Networks

University of Notre Dame (USD 10,000)

2013–2014 FAPESP (State of São Paulo Research Foundation) – Postdoctorate

(re)discovery and analysis of metal-poor stars in the Milky Way

National Optical Astronomy Observatory (USD 71,400)

2010–2013 FAPESP (State of São Paulo Research Foundation) – Postdoctorate

The Milky Way Halo revisited

Universidade de São Paulo (USD 85,500)

### **Fellowships**

2007–2010 Doctorate – FAPESP (07/04356-3) – Universidade de São Paulo Search for very metal-poor stars based on carbon over-abundance
 2005–2007 Master's – FAPESP (05/01023-8) – Universidade de São Paulo Abundance patterns among very metal-poor stars in the Galaxy: a statistical approach
 2004–2005 Undergraduate research project – CNPq/PIBIC – Universidade de São Paulo Descoberta e Análise de Objetos com Linhas em Emissão no Survey HK
 2002–2004 Undergraduate research project – FAPESP (02/04704-8) – Universidade de São Paulo Construção de câmara de alvo gasoso para produção de feixes radioativos

# Visiting Faculty/Postdoc/Graduate Student

2018 Universidade de São Paulo Instituto de Astronomia, Geofísica e Ciências Atmosféricas Funding: USP/FAPESP/JINA-CEE

2018 Chungnam National University
Department of Astronomy & Space Science
Funding: CNU

University of Notre Dame
 Department of Physics
 Funding: Gemini Observatory and JINA (Joint Institute for Nuclear Asthophysics)

2014/2012 Massachusetts Institute of Technology

Kavli Institute for Astrophysics and Space Research

Funding: Gemini Observatory, FAPESP (The State of São Paulo Research Foundation - Brazil)

2013/2012 National Optical Astronomy Observatory

Kitt Peak National Observatory Funding: FAPESP (Brazil)

2013 New Mexico State University Department of Astronomy Funding: FAPESP (Brazil)

2010/2008 Universität Heidelberg Zentrum für Astronomie

Funding: Universität Heidelberg (Germany), FAPESP, PROEX (Brazil)

2010/2009 Michigan State University

2007 Physics and Astronomy Department

Funding: JINA (USA), FAPESP, PROEX (Brazil)

# **Academic Experience**

# **Teaching**

Lead Instructor (LI) / Co-Instructor (CI) / Guest Lecturer (GL)

### Undergraduate

- 2020 (LI) Descriptive Astronomy (SP20-PHYS-10140)

  Course Instructor Feedback: 5.0/5.0 link to full report
  - (LI) General Physics B E & M Laboratory (SP20-PHYS-11422)

    Course Instructor Feedback: 5.0/5.0 link to full report
  - (GL) Engineering Physics II Laboratory (SP20-PHYS-11320)
  - (GL) Engineering Physics I Laboratory (SP20-PHYS-11310)
- 2019 (LI) Physics A Mechanics Laboratory (FA19-PHYS-11411)

  Course Instructor Feedback: 5.0/5.0 link to full report
  - (LI) Descriptive Astronomy (SU19-PHYS-10140)

    Course Instructor Feedback: 5.0/5.0 link to full report
- 2018 (GL) Descriptive Astronomy (FA18-PHYS-10140)
- 2017 (CI) Descriptive Astronomy (FA17-PHYS-10140)
  - (LI) General Physics B E & M Laboratory (SP17-PHYS-11422)

    Course Instructor Feedback: 4.8/5.0 link to full report
- 2016 (GL) Descriptive Astronomy (FA16-PHYS-10140)
- 2015 (GL) Modern Observational Techniques (FA15-PHYS-30481)

### Universidade Virtual do Estado de São Paulo

- 2012 (LI) Sky and Stars: An introduction
  - (LI) Galaxies: An introduction
- 2011 (LI) Sky and Stars: An introduction
  - (LI) Galaxies: An introduction

### Graduate

# **University of Notre Dame**

- 2017 (CI) Astrophysics: Stars (SP17-PHYS-80202)
- 2016 (CI) Large-Scale Astronomical Surveys (SP16-PHYS-70210)
- 2015 (GL) Astrophysics: Stars (SP15-PHYS-80202)

#### Universidade de São Paulo

2012 (GL) Observational Astronomy

### Teaching Assistant - Universidade de São Paulo

2009 Introduction to Astronomy
 Fundamental Astronomy
 2008 Introduction to Astronomy
 Fundamental Astronomy

# Student/Postdoc supervision

```
Postdoctoral level
2019-present
              Hélio Dotto Perottoni (Universidade de São Paulo)
Graduate Level (co-advisor) - University of Notre Dame
              Guilherme Limberg (Universidade de São Paulo)
2020-present
2019-present
              Carlos Andrés Galarza Arevalo (Observatório Nacional - Brazil)
2019-present
              Joseph Zepeda
2019-present
              Derek Shank
             Devin Whitten
2015-present
2015-present
              Sarah Dietz
              Dmitrii Gudin
2015-present
 2015-2020
              Erika Holmbeck
 2015-2020
             Kaitlin Rasmussen
  2015-2017
              Geoffrey Lentner
 2010-2016
              Rafael Santucci (M.Sc. and Ph.D. - Universidade de São Paulo)
Undergraduate Level (advisor) - University of Notre Dame
2020-present
              Dante Komater (Physics Major)
2019-present
              Lucas Pinheiro (Engineering Major)
              Shenghua Liu (Physics Major)
       2019
       2019
              Winter Allen (Arkansas Tech University - REU)
       2019
              Yihao Zhou (Shanghai Jiao Tong University - REU)
  2018-2020
              Guilherme Limberg (Universidade de São Paulo)
              Erik Peterson
 2016-2018
 2016-2018
             David Kalamarides
              Spencer Clark (Glynn Family Honors Program) - Senior Thesis
 2015-2018
 2016-2017
              John Roach
 2016-2017
              Cristobal Gonzales
 2016-2017
              Michael Kurkowski
       2017
              Jazmine Jefferson (University of Kansas - REU)
       2017
              Derek Shank (Ohio Wesleyan University - DISC/REU) - video report
       2017
              Diego Fernandez (University of Oregon - REU)
       2016
              Travis Hodges (Austin Peav State University - DISC/REU)
              Miguel Correa (San Diego State University - REU)
       2016
       2015
              Siyu He (Xi'an Jiaotong University - REU)
  2012-2014 William Alves (Universidade de São Paulo)
  2008-2010
              Rafael Santucci (Universidade de São Paulo)
Committee Service - University of Norte Dame
              Undergraduate Research, Department of Physics
2019-present
  2016-2018
              Graduate Recruitment, Department of Physics
  2015-2018
              Preliminary Exam Committee, Department of Physics
  2015-2018
              University Committee on Research & Sponsored Programs, Notre Dame Research
Thesis Defense Committee
              Heitor Ernandes (Ph.D. - committee chair)
              Universidade de São Paulo
       2019
              Henrique Reggiani (Ph.D.)
              Universidade de São Paulo
             Rafael Miloni Santucci (Ph.D.)
       2016
              Universidade de São Paulo
       2016
              Camilo Francisco Javier Muñoz Peña (M.Sc.)
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Universidade de São Paulo

### Other relevant information

# Computing skills

Linux/Unix/MACOSX/Windows operating systems

Shell Scripting (sh, bash, tcsh, zsh)

LATEX, OpenOffice, MS Office. Co-author of the LATEX template IAGTESE

Python (iPython/Jupyter Notebooks): scipy, numpy, pandas, scikitlearn, pyfits, astropy

R-project (terminal/RStudio): FITSio, tidyverse, cluster, sciviews

Databases: SQL (PostgreSQL/pgAdmin3), SDSS CasJobs, ADQL (J-PLUS/J-PAS/TAPVizieR)

Web: html, ccs, wordpress, apache, curl, wget, ssh, ftp Graphics: Gnuplot, ggplot2, matplotlib, bokeh, tableau

Data reduction: IRAF/Pyraf/Gemini packages, focused on spectroscopy

Astronomy tools: WCSTools, CDSclient, STILTS, SkyCalc

Version control: Git

### Online Resources

Webpage: http://vmplacco.github.io/

LinkedIn: https://www.linkedin.com/in/vinicius-placco/

GitHub: https://github.com/vmplacco/

stackoverflow: https://stackoverflow.com/users/5964833/vinicius-placco

pythonanywhere: https://vplacco.pythonanywhere.com/

Sample webpages/

side projects: http://vmplacco.github.io/#resources

### Professional Affiliations/Service

Member of the American Astronomical Society

Member of the Brazilian Astronomical Society

Member of the Brazilian Physical Society

Member of the JINA Center for the Evolution of the Elements

Referee for the American Astronomical Society Journals

Referee for the AAAS Science Magazine

Referee for Astronomy & Astrophysics

Referee for Monthly Notices of the Royal Astronomical Society

# \* Invited / Contributed talks

### 2020

\* NSF's National Optical-Infrared Astronomy Research Laboratory
Near-Field Cosmology with Narrow-Band Photometry and Spectroscopy of Low-Metallicity Stars

- \* Universidade de São Paulo Astrophysics Colloquium Near-Field Cosmology using Narrow-Band Photometry and Low-Metallicity Stars
- \* Universidade de São Paulo Astronomia ao Meio-dia Agulhas no palheiro: A evolução química e idade do Universo contadas por duas estrelas

### 2019

- \* National Optical Astronomy Observatory
  Stellar Archaeology: Understanding the Chemical Evolution of the Universe through Color Maps of the Night Sky
- \* Joint Institute for Nuclear Astrophysics Physics of Atomic Nuclei High School Program The Age and Chemical Evolution of the Universe from two stars in the Milky Way

Consejo Superior de Investigaciones Científicas – 17th J-PAS Collaboration Meeting Identification of Low-Metallicity Stars from Narrow-Band Photometry

\* San Francisco State University – Physics & Astronomy Colloquium
Stellar Archaeology: Origin of the Chemical Elements in the Universe through a 59-Color Map of the Sky

#### 2018

\* Kavli IPMU at The University of Tokyo – Stellar Archaeology as a Time Machine to the First Stars The Mass Distribution of the First Stars revealed by Abundance Pattern Matching of Ultra Metal-Poor Stars

Kavli IPMU at The University of Tokyo – Introduction to Stellar Archaeology Radioactive Stellar Ages

- \* Texas A&M University Commerce Physics & Astronomy Colloquium
  Stellar Archaeology: Understanding the Origin of the Chemical Elements through a 59-Color Map of the Night Sky
- \* Chungnam National University Department of Astronomy & Space Science Seminar The Origin of the Chemical Elements in the Universe revealed by a 12-Color Map of the Night Sky
- \* Korea Astronomy and Space Science Institute Colloquium
  Constraints on Near-Field Cosmology through Abundance Pattern Matching of Ultra Metal-Poor Stars
- Universidade de São Paulo Astronomy Colloquium
  The Southern Photometric Local Universe Survey (S-PLUS): An Overview

Universidade de São Paulo – S-PLUS Meeting Short update on S-PLUS SHORTS

University of Notre Dame – Astronomy 1-minute talks (23 presenters) Organizer

\* University of Notre Dame – Our Universe Revealed A day in the life of an Astronomer

Kavli Institute for Cosmological Physics – Near-Field Cosmology with the Dark Energy Survey The Age Structure of the Milky Way Halo revealed by DES

\* Joint Institute for Nuclear Astrophysics – Physics of Atomic Nuclei High School Program Can we talk about the Age and Chemical Evolution of the Universe by looking at only two stars?

Centro de Estudios de Física del Cosmos de Aragón – J-PLUS  $2^{\rm nd}$  Virtual Meeting *J-PLUS Stellar Parameter Value Added Catalog* 

\* Shanghai Jiao Tong University – Tsung-Dao Lee Institute Workshop on The Exploding Universe Probing the mass distribution of the first stars through abundance pattern matching of ultra metal-poor stars

- \* JINA-CEE Frontiers in Nuclear Astrophysics Main Conference
  Observational constraints on the origin of the elements: from First stars to Neutron-Star mergers
- \* Manhattan College Physics Department Understanding the Origin of the Elements in the Universe through a 12-Color Map of the Night Sky
- \* JINA-CEE Frontiers in Nuclear Astrophysics Junior Workshop Speaking Skills
- \* Centro de Estudios de Física del Cosmos de Aragón 16th J-PAS Collaboration Meeting Pathfinder science Constraints on First-Star Nucleosynthesis from J-PAS Photometry of Low-Metallicity Stars

Universidade de São Paulo – S-PLUS Collaboration Meeting (online) Updates on S-PLUS Short Survey(s)

### 2017

Universidade de São Paulo – S-PLUS Collaboration Meeting (online) Updates on S-PLUS Short Survey(s)

\* Michiana Astronomical Society – MAS monthly meeting speaker A Tale of Two Stars: Revealing the Age and Chemical Evolution of the Universe

University of Notre Dame – Astro-Skills Lunch *The do's and don'ts when plotting data* 

Red de Infraestructuras de Astronomia – Early Data Release and Scientific Exploitation of the J-PLUS Survey Identification of (Bright) Carbon-Enhanced Metal-Poor Stars with J-PLUS Photometry

GMT Community Science Meeting – Chemical Evolution of the Universe A Monte Carlo approach to find the Progenitors of Ultra Metal-Poor Stars (Rapid Poster Talk)

University of Notre Dame – The Great American Eclipse at Notre Dame Co-organizer / Astronomy faculty representative – 3,500 attendees

\* University of Notre Dame – Research Experiences for Undergraduates (REU) Program
A needle in a haystack: What one star can tell us about the age and chemical evolution of the entire Universe

Centro de Estudios de Física del Cosmos de Aragón – J-PLUS 1<sup>st</sup> Virtual Meeting *Identifying (Carbon-Enhanced) Metal-Poor Stars from J-PLUS Photometry* 

- \* Joint Institute for Nuclear Astrophysics Physics of Atomic Nuclei High School Program Stellar Archaeology: The Age and Chemistry of the Universe revealed by old Stars
- \* Universidade de São Paulo Astrophysics Colloquium Searching for the Origin of the Elements Using a 12-Color Map of the Night Sky

# 2016

- \* University of Notre Dame Astrophysics Seminar A Monte Carlo approach to find the Progenitors of Ultra Metal-Poor Stars
- \* University of Notre Dame Department of Physics Colloquium Searching for the Origin of the Elements Using a 12-Color Map of the Night Sky

University of Notre Dame – Astronomy 1-minute talks (19 presenters) Organizer

Universidade de São Paulo – X-PLUS Collaboration Meeting Identifying Bright Carbon-Enhanced Metal-Poor Stars from S-PLUS Photometry

- \* University of Notre Dame Research Experiences for Undergraduates (REU) Program Near-Field Cosmology with Metal-Poor Stars
- \* University of Notre Dame Our Universe Revealed A day in the life of an Astronomer

University of Notre Dame – Our Universe Revealed Our eyes in the skies: How telescopes help us place ourselves in the Universe

227th Meeting of the American Astronomical Society Identifying Bright Carbon-Enhanced Metal-Poor Stars in the RAVE Catalog

### 2015

University of Notre Dame – Our Universe Revealed The stuff we are made of: how do we determine the chemical elements in stars and the Universe?

University of Notre Dame – Astronomy 1-minute talks (15 presenters) Organizer

- \* Joint Institute for Nuclear Astrophysics / University of Notre Dame High School On Air Talk Stellar Archaeology: The Age and Chemistry of the Universe revealed by old Stars YouTube video
- \* Michigan State University JINA-CEE Nuclear Astrophysics Lunch Research Discussions Observing the First Stars through the Atmospheres of Ultra Metal-Poor Stars

Universidade de São Paulo – X-PLUS Collaboration Meeting Identifying Carbon-Enhanced Metal-Poor Stars from S-PLUS Photometry

University of Notre Dame – Research Experiences for Undergraduates (REU) Program Galactic Archaeology: The Chemical Evolution and Age of the Universe revealed by old Stars

### 2014

- \* University of Notre Dame Astronomy Seminar
  Exploring the history of the Galactic halo with Carbon-Enhanced Metal-Poor stars
- \* Massachusetts Institute of Technology Kavli Institute Exploring the history of the Galactic halo with Carbon-Enhanced Metal-Poor stars

### 2013

National Optical Astronomy Observatory (Carbon Enhanced) metal-poor stars and the chemical evolution of the Universe

\* Gemini Observatory – Northern Operations Center Metal-poor stars as tracers of the chemical evolution of the Galaxy

### 2012

- \* Universidade Cruzeiro do Sul Astronomy Colloquium Search for Carbon-Enhanced Metal-Poor stars in the Halo(es) of the Galaxy
- \* Universidade de São Paulo Astronomy Colloquium Spectroscopy from R=300 to 30000: metal-poor stars and Galactic chemical evolution
- \* Universidade de São Paulo Invitation to Physics: undergraduate weekly seminar Galactic Archaeology: chemical evolution of the Universe revealed by metal-poor stars

Universidade de São Paulo - Astronomy at noon: undergraduate weekly seminar  $\it Census~of~the~Milky~Way$ 

### 2011

Universidade de São Paulo - Chemical Evolution Group Seminar Rediscovering the Dual Halo of the Milky Way via Hierarquical Clustering

Universidade de São Paulo - Astronomy at noon: undergraduate weekly seminar  $Stellar\ Archaeology$ 

Universidade de São Paulo - Astronomy Colloquium

Making good use of bad weather: finding extremely metal-poor stars in the clouds

\* ESO Headquarters - Santiago - Astronomy Colloquium Searches for Metal-Poor Stars from the Hamburg/ESO Survey using the CH G-band

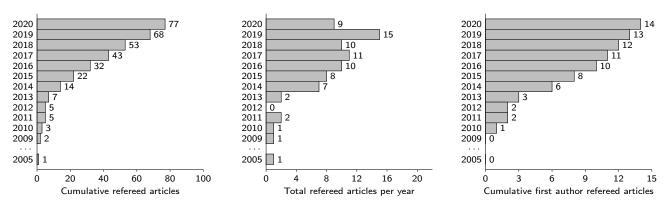
# Quantitative Indicators

- ADS: 3364 citations / h-index = 26 / i10-index = 55 (June 17, 2020 ADS link)
- Google Scholar: 3759 citations / h-index = 29 / i10-index = 54 (June 17, 2020 Google Scholar link)
- ADS Publication List (complete ADS link) / (refereed only ADS link)
- ORCID iD 0000-0003-4479-1265 / ResearcherID C-6864-2015

### **Publication list**

### Refereed articles

Total: 77 publications (14 first author, 8 second author, 10 third author)



- Placco, V. M., J-PLUS Collaboration, S-PLUS Collaboration
   Finding Metal-Poor Stars from Narrow-Band Photometry: Spectroscopic Validation using Gemini Poor-Weather
   2020, The Astrophysical Journal, in preparation
- 77. Rasmussen, K., Zepeda, J., Beers, T. C., Placco, V. M., Depagne, É., Frebel, A., Dietz, S., Hartwig, T. *Metal-Poor Stars Observed with the Southern African Large Telescope* 2020, The Astrophysical Journal, submitted
- Placco, V. M., Santucci, R. M., Yuan, Z., Mardini, M. K., Holmbeck, E. M., Wang, X., Surman, R., Hansen, T., Roederer, I. U., Beers, T., Choplin, A., Ji, A., Ezzeddine, R., Frebel, A., Sakari, C., Whitten, D., Zepeda, J. The R-Process Alliance: The Peculiar Chemical Abundance Pattern of RAVE J183013.5—455510
   2020, The Astrophysical Journal, in press
- 75. Cain, M., Frebel, A., Ji, A. P., **Placco, V. M.**, Ezzeddine, R., Roederer, I. U., Hattori, K., Beers, T. C., Meléndez, J., Hansen, T. T., Sakari, C.

  The R-Process Alliance: J1521—3538, a Very Metal-Poor, Extremely r-Process-Enhanced Star with [Eu/Fe] = +2.2, and the Class of r-III Stars

  2020, The Astrophysical Journal, in press
- 74. Holmbeck, E. M., Hansen, T. T., Beers, T. C., Placco, V. M., Whitten, D. D., Rasmussen, K. C., Roederer, I. U., Sakari, C., Ezzeddine, R., Frebel, A., Drout, M. R., Simon, J. D., Thompson, I. B., Bland-Hawthorn, J., Gibson, B. K., Grebel, E. K., Kordopatis, G., Kunder, A., Meléndez, J., Navarro, J. F., Reid, W. A., Seabroke, G., Steinmetz, M., Watson, F., Wyse, R. F. G.

  The R-Process Alliance: Fourth Data Release from the Search for r-Process-Enhanced Stars in the Galactic Halo
  - The R-Process Alliance: Fourth Data Release from the Search for r-Process-Enhanced Stars in the Galactic Halo **2020**, **The Astrophysical Journal**, in press
- 73. Ezzeddine, R., Rasmussen, K., Frebel, A., Chiti, A., Hinojisa, K., Placco, V. M., Beers, T. C., Hansen, T. T., Roederer, I. U., Sakari, C. M., Ji, A. P., Melendez, J.

- The R-Process Alliance: First Magellan/MIKE Release from the Southern Search for R-Process-enhanced Stars 2020, The Astrophysical Journal, in press
- 72. Molino, A., Costa-Duarte, M. V., Sampedro, L., Herpich, F. R., Sodré, L., Jr., Mendes de Oliveira, C., Schoenell, W., Barbosa, C. E., Queiroz, C., Lima, E. V. R., Azanha, L., Muñoz-Elgueta, N., Ribeiro, T., Kanaan, A., Hernandez-Jimenez, J. A., Cortesi, A., Akras, S., Lopes de Oliveira, R., Torres-Flores, S., Lima-Dias, C., Nilo Castellon, J. L., Damke, G., Alvarez-Candal, A., Jiménez-Teja, Y., Coelho, P., Pereira, E., Montero-Dorta, A. D., Benítez, N., Gonçalves, T. S., Santana-Silva, L., Werner, S. V., Almeida, L. A., Lopes, P. A. A., Chies-Santos, A. L., Telles, E., de Souza, T. C. R., Gonçalves, D. R., de Souza, R. S., Makler, M., Placco, V. M., Nakazono, L. M. I., Saito, R. K., Overzier, R. A., Abramo, L. R. Assessing the photometric redshift precision of the S-PLUS survey: the Stripe-82 as a test-case 2020, Monthly Notices of the Royal Astronomical Society, in press
- 71. Dietz, S. E., Yoon, J., Beers, T. C., Placco, V. M.

  The Metallicity Gradient and Complex Formation History of the Outermost Halo of the Milky Way

  2020, The Astrophysical Journal, vol. 894, 34 (ADS link | download pdf)
- 70. Yoon, J., Whitten, D. D., Beers, T. C., Lee, Y. S., Masseron, T., Placco, V. M. *Identification of a Group III CEMP-no Star in the Dwarf Spheroidal Galaxy Canes Venatici I* 2020, The Astrophysical Journal, vol. 894, 7 (ADS link | download pdf)
- Yuan, Z., Myeong, G. C., Beers, T. C., Evans, N. W., Lee, Y. S., Banerjee, P., Gudin, D., Hattori, K., Li, H., Matsuno, T., Placco, V. M., Smith, M. C., Whitten, D. D., Zhao, G. Dynamical Relics of the Ancient Galactic Halo
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# Telescope time allocations

Approved observing projects: 139 Total awarded: 6082.36 hours

## Principal Investigator

Approved observing projects: 44 Total awarded: 1555.55 hours

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44. 2020A - CTIO Blanco - 2020A-0032: 5.0 nights
43. 2019B - CTIO Blanco - 2019B-0069: 5.0 nights
42. 2019A - Gemini South - GS-2019A-Q-408 (Band 4): 21.0 hours
41. 2019A - Gemini North - GN-2019A-Q-402 (Band 4): 27.0 hours
40. 2018B - Gemini North - GN-2018B-Q-403 (Band 4): 20.0 hours
39. 2018B - Gemini South - GS-2018B-Q-402 (Band 4): 20.0 hours
38. 2018A - Gemini South - GS-2018A-Q-402 (Band 4): 30.0 hours
37. 2017B - Gemini North - GN-2017B-Q-84 (Band 4): 39.0 hours
36. 2017A - Gemini South - GS-2017A-FT-3: 5.5 hours
35. 2017A - KPNO Mayall - 2017A-0295: 7.0 nights
34. 2016B - Gemini North - GN-2016B-Q-85 (Band 4): 50.0 hours
33. 2016B - Gemini South - GS-2016B-Q-86 (Band 4): 50.0 hours
32. 2016A - Gemini South - GS-2016A-Q-107 (Band 4): 50.0 hours
31. 2015B - Gemini North - GN-2015B-Q-100 (Band 4): 30.0 hours
30. 2015B - Gemini South - GS-2015B-Q-104 (Band 4): 50.0 hours
29. 2015B - ESO/NTT - 096.D-0018(A): 5.0 nights
28. 2015A - Gemini North - GN-2015A-Q-401 (Band 4): 30.0 hours
27. 2015A - Gemini South - GS-2015A-Q-205 (Band 4): 50.0 hours
26. 2015A - ESO/NTT - 095.D-0202(A): 4.0 nights
25. 2015A - KPNO Mayall - 2015A-0071: 6.0 nights
24. 2015A - SOAR - 2015A-0071: 5.0 nights
23. 2014B - Gemini South - GS-2014B-Q-85 (Band 4): 30.0 hours
22. 2014B - Gemini North - GN-2014B-Q-102 (Band 4): 30.0 hours
21. 2014A - Gemini South - GS-2014A-Q-92 (Band 4): 33.3 hours
20. 2014A - Gemini North - GN-2014A-Q-101 (Band 3): 16.7 hours
19. 2014A - Gemini North - GN-2014A-Q-105 (Band 4): 33.3 hours
18. 2013B - Gemini South - GS-2013B-Q-89 (Band 4): 25.0 hours
17. 2013B - Gemini North - GN-2013B-Q-105 (Band 4): 25.0 hours
16. 2013B - SOAR - SO2013B-001: 30.0 hours
15. 2013A - SOAR - SO2013A-018: 34.0 hours
14. 2012B - Gemini South - GS-2012B-Q-65 (Band 3): 10.0 hours - queue
13. 2012B - Gemini South - GS-2012B-Q-84 (Band 4): 70.0 hours - queue
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12. 2012B - Gemini North - GN-2012B-Q-284 (Band 4): 70.0 hours - queue

- 11. 2012B ESO/NTT 090.D-0275(A): 4 nights classical
- 10. 2012B SOAR SO2012B-001: 24.0 hours remote
- 9. 2012A Gemini South GS-2012A-Q-76 (Band 3): 6.0 hours queue
- 8. 2012A ESO/NTT 089.D-0331(A): 4 nights classical
- 7. 2012A SOAR SO2012A-003: 24.0 hours remote
- 6. 2011B ESO/NTT 088.D-0344(A): 4 nights classical
- 5. 2011B SOAR SO2011B-002: 24.0 hours remote
- 4. 2011A Gemini South GS-2011A-Q-86 (Band 4): 4.0 hours queue
- 3. 2011A Gemini North GN-2011A-Q-88 (Band 3): 1.3 hours queue
- 2. 2011A Gemini North GN-2011A-Q-122 (Band 4): 6.7 hours queue
- 1. 2011A SOAR SO2011A-010: 17.0 hours remote

# Co-Investigator

# Approved observing projects: 95 Total awarded: 4526.81 hours

- 95. 2020A McDonald 2.7m McD20-1-2.7-7: 7.0 nights
- 94. 2019B Gemini North GN-2019B-Q-403 (Band 4): 9.40 hours
- 93. 2019B McDonald 2.7m McD19-3-2.7-1: 7.0 nights
- 92. 2019B SOAR 2019B-0013: 26 hours
- 91. 2019A Gemini North GN-2019A-Q-309 (Band 3): 22.73 hours
- 90. 2019A McDonald 2.7m McD19-1-2.7-3: 17.0 nights
- 89. 2019A McDonald 2.1m McD19-1-2.7-1: 5.0 nights
- 88. 2018B Gemini North GN-2018B-Q-122 (Band 1): 10.0 hours
- 87. 2018B Gemini North GN-2018B-Q-316 (Band 3): 25.00 hours
- 86. 2018B Gemini South GS-2018B-Q-315 (Band 3): 47.27 hours
- 85. 2018B SOAR 2018B-0010: 26 hours
- 84. 2018A Gemini North GN-2018A-Q-403 (Band 4): 89.10 hours
- 83. 2018A Gemini South GS-2018A-Q-406 (Band 4): 7.90 hours
- 82. 2018A LCO/Magellan Telescope Carnegie Time: 2 nights
- 81. 2018A LCO/duPont Telescope Carnegie Time: 18 nights
- 80. 2018A Apache Point Observatory UW08: 5.0 nights
- 79. 2018A LCO/Magellan Telescope Chilean Time: 3 nights
- 78. 2018A SOAR 2018A-0021: 36 hours
- 77. 2018A McDonald 2.7m McD18-1-2.7-3: 7.0 nights
- 76. 2017B LCO/Magellan Telescope Michigan Time: 2.5 nights
- 75. 2017B Gemini North GN-2017B-Q-18 (Band 1): 10.2 hours
- 74. 2017B Gemini North GN-2017B-FT-7: 6.28 hours
- 73. 2017B Gemini North GN-2017B-Q-75 (Band 3): 41.82 hours
- 72. 2017B Gemini North GN-2017B-Q-79 (Band 4): 63.64 hours
- 71. 2017B Gemini South GS-2017B-Q-75 (Band 3): 20.91 hours

- 70. 2017B Gemini South GS-2017B-Q-84 (Band 4): 107.82 hours
- 69. 2017A Southern African Large Telescope 2017-1-MLT-012: 55.6 hours
- 68. 2017A Gemini North GN-2017A-Q-82 (Band 3): 202.0 hours
- 67. 2017A Gemini South GS-2017A-Q-86 (Band 3): 142.5 hours
- 66. 2017A ESO/NTT 099.D-0428: 5.0 nights
- 65. 2017A LCO/Magellan Telescope Carnegie Time: 3 nights
- 64. 2017A LCO/duPont Telescope Carnegie Time: 19 nights
- 63. 2017A SOAR 2017A-0016: 40 hours
- 62. 2016B Gemini North GN-2016B-Q-77 (Band 3): 6.4 hours
- 61. 2016B Gemini South GS-2016B-Q-81 (Band 3): 32.3 hours
- 60. 2016B ESO/NTT 098.D-0434: 4.0 nights
- 59. 2016B Hubble Space Telescope Cycle 24 HST-GO-14765: 40 orbits
- 58. 2016B LCO/duPont Telescope Carnegie Time: 5 nights
- 57. 2016A ESO/NTT 097.D-0196: 7.0 nights
- 56. 2016A Apache Point Observatory UW07: 2.5 nights
- 55. 2016A Gemini North GN-2016A-Q-17 (Band 1): 9.8 hours
- 54. 2016A Gemini North GN-2016A-Q-75 (Band 3): 79.4 hours
- 53. 2016A Gemini South GS-2016A-Q-76 (Band 3): 74.0 hours
- 52. 2016A SOAR 2016A-0019: 4.0 nights
- 51. 2015B Southern African Large Telescope 2015-2-SCI-056: 117.8 hours
- 50. 2015B Hubble Space Telescope Cycle 23 HST-GO-14231: 18 orbits
- 49. 2015B Gemini North GN-2015B-Q-86 (Band 3): 26.5 hours
- 48. 2015B Gemini South GS-2015B-Q-71 (Band 3): 42.9 hours
- 47. 2015B SOAR 2015B-0020: 5.0 nights
- 46. 2015A ESO/VLT 095.D-0504(A): 30.0 hours
- 45. 2015A Gemini North GN-2015A-Q-76 (Band 3): 45.8 hours
- 44. 2015A Gemini South GS-2015A-Q-77 (Band 3): 42.8 hours
- 43. 2015A Gemini South GS-2015A-Q-92 (Band 4): 26.0 hours
- 42. 2014B ESO/VLT DDT293.D-5036(A): 2.4 hours
- 41. 2014B Gemini South GS-2014B-Q-67 (Band 3): 55.0 hours
- 40. 2014B Gemini North GN-2014B-Q-85 (Band 3): 55.0 hours
- 39. 2014B KPNO Mayall 2014B-0231: 3.0 nights
- 38. 2014B SOAR 2014B-0231: 3.0 nights
- 37. 2014A Gemini South GS-2014A-Q-88 (Band 3): 66.7 hours
- 36. 2014A KPNO Mayall 2014A-0323: 8.0 nights
- 35. 2013B KPNO Mayall 2013B-0046: 6.5 nights
- 34. 2013B Gemini South GS-2013B-Q-75 (Band 3): 50.0 hours
- 33. 2013B Gemini North GN-2013B-Q-81 (Band 3): 50.0 hours
- 32. 2013B SOAR SO2013B-S102: 17.0 hours (long term)
- 31. 2013B ESO/NTT 092.D-0308(A): 6 nights

- 30. 2013B McDonald 2.1m McD13-3: 5 nights
- 29. 2013B LNA/Brazil 2013B-P012: 6 nights
- 28. 2013B NOT (Nordic Optical Telescope) 48-031: 3.5 nights
- 27. 2013A Gemini North GN-2013A-Q-113 (Band 4): 54.5 hours
- 26. 2013A Gemini South GS-2013A-Q-91 (Band 3): 54.6 hours
- 25. 2013A Gemini South GS-2013A-Q-95 (Band 4): 10.9 hours
- 24. 2013A ESO/NTT 091.D-0292(A): 6 nights
- 23. 2013A LNA/Brazil 2013A-P030: 4 nights
- 22. 2013A SOAR SO2013A-LP2: 17.0 hours (long term)
- 21. 2013A NOT (Nordic Optical Telescope) 47-003: 3.0 nights
- 20. 2012B NOT (Nordic Optical Telescope) 46-011: 2.5 nights
- 19. 2012B ESO/VLT (X-Shooter) 090.D-0321(A): 12 hours
- 18. 2012B LCO/Magellan MAG/12B/9: 2 nights
- 17. 2012B AAO/AAT AAT/12B/032: 6 nights
- 16. 2012B SOAR SO2012B-005: 8.0 hours (long term)
- 15. 2012A Gemini South GS-2012A-Q-81 (Band 4): 74.0 hours
- 14. 2012A AAO/AAT AAT/12A/011: 4 nights
- 13. 2012A LCO/Magellan MAG/12A/7: 2 nights
- 12. 2012A SOAR SO2012A-002: 16.0 hours
- 11. 2011B Gemini South GS-2011B-Q-91 (Band 4): 75.0 hours
- 10. 2011B SOAR (SO2011B-008): 24.0 hours
- 9. 2011A Gemini South GS-2011A-Q-85 (Band 3): 63.4 hours
- 8. 2011A CFHT CF2011A-002: 13.9 hours
- 7. 2010B CFHT 10BB05A/10BB99B: 13.9 hours
- 6. 2010A Gemini South GS-2010A-Q-78 (Band 4): 25.0 hours
- 5. 2009B SOAR SO2009B-004: 17.0 hours
- 4. 2009A SOAR SO2009A-0249: 6 nights
- 3. 2009A SOAR SO2009A-014: 32.0 hours
- 2. 2008A SOAR SO2008A-006: 3 nights
- 1. 2007B SOAR SO2007B-006: 3 nights

# Press releases, articles, and media resources

### 2020

Inside Higher Ed (online)

The rise of the remote Ph.D. defense

Gemini Observatory - GeminiFocus 2019 Year In Review (online)

Making Good Use of Bad Weather: Finding Metal-poor Stars Through the Clouds

### 2019

MIT News (online)

Explosions of universe's first stars spewed powerful jets

Gemini Observatory News (online)

Making Good Use of Bad Weather: Finding Metal-poor Stars Through the Clouds

Gemini Observatory - GeminiFocus April 2019 Lead Science Article (online)

Making Good Use of Bad Weather: Finding Metal-poor Stars Through the Clouds

#### 2018

Notre Dame Science - Department of Physics News (online)

Summertime Stargazing event draws large crowd

Notre Dame Stories (online)

Heavy Metals

### 2017

Revista FAPESP (in Portuguese - online)

Fonte de ouro e régua do universo

Agência FAPESP (in Portuguese - online)

Nova fonte de ondas gravitacionais é observada

Notre Dame News (online)

Students in right place, right time witness first-ever detected neutron star collision

Notre Dame College of Science News (online)

Astrophysics graduate students witness first-ever detected neutron star collision

Agência FAPESP (in Portuguese - online)

Estudo detecta elétrons duplamente acelerados no choque de aglomerados de galáxias

École Polytechnique News (online)

The inaugural issue of Nature Astronomy features the work of F. Andrade-Santos

Jornal da USP (in Portuguese - online)

Cientistas descobrem poderosa colisão cósmica dupla

Folha de São Paulo (in Portuguese - online)

Quando aglomerados de galáxias colidem e um buraco negro gigante entra no meio da história

Nature Astronomy (online - issue cover)

The case for electron re-acceleration at galaxy cluster shocks

Chandra X-ray Observatory Blog (online)

The Discovery of Particle Re-acceleration in a Galaxy Cluster Collision

Notre Dame News (online)

Notre Dame astrophysicist confirms source of galaxy collision

#### 2016

Nature Physics (online - issue cover)

The age structure of the Milky Way's halo

Notre Dame News (online)

Second-generation stars identified, giving clues about their predecessors

Science Alert (online)

Astronomers have created the most detailed age map of the Milky Way yet

Universe Today (online)

Best picture yet of Milky Way's formation 13.5 billion years ago

Notre Dame News (online)

Detailed age map shows how Milky Way came together

Daily Mail (online)

How the Milky Way formed: Stunning 3D maps show how 130,000 stars came together 13.5 billion years ago

Daily Mail (online)

Graphic shows age structure of the Milky Way's halo

Astrobites (online)

Our halo is getting younger, spatially speaking

UPI (online)

New map details formation of the Milky Way galaxy

International Business Times (online)

How Did The Milky Way Form? New Chronographic Map Provides Answers

Phys.org (online)

Detailed age map shows how Milky Way came together

Reddit Journal of Science (online)

Detailed age map shows how Milky Way came together

Science Daily (online)

Detailed age map shows how Milky Way came together

Laboratory Equipment (online)

Detailed age map shows how Milky Way came together

Geek Journal (online)

Detailed age map shows how Milky Way came together

AboNewsCast (online)

Detailed age map shows how Milky Way came together

Science Newsline (online)

Detailed age map shows how Milky Way came together

MSU Today (online)

Astronomers pinpoint how Milky Way Galaxy was formed

Ancient Code (online)

How the Milky Way formed: Awesome 3D map shows how 130,000 stars merged

Astro Watch (online)

Detailed Age Map Shows How Milky Way Came Together

Science Bulletin (online)

Detailed Age Map Shows How Milky Way Came Together

Science Blog (online)

Astronomers pinpoint how Milky Way Galaxy was formed

EurekAlert! (online)

Detailed Age Map Shows How Milky Way Came Together

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Detailed Age Map Shows How Milky Way Came Together

Life Science Network (online)

The age structure of the Milky Way's halo

Jornal da USP (in Portuguese - online)

Astrônomos brasileiros mapeiam estrutura de idades do halo da Via Láctea

Agência FAPESP (in Portuguese - online)

Pesquisadores mapeiam a distribuição cronológica dos astros da Via Láctea

Revista Galileu (in Portuguese - online)

Brasileiros confirmam que estrelas na borda da Via Láctea são as mais novas

O Povo (in Portuguese - online)

Como os astros da Via Láctea se distribuem?

Space Today TV (in Portuguese - online)

Como a Via Láctea Se Formou

Público (in Spanish - online)

Así se formó la Vía Láctea

Geofísica Brasil (in Portuguese - online)

IAG-USP mapeia distribuição cronológica dos astros da Via Láctea

Planeta Universitário (in Portuguese - online)

Pesquisadores mapeiam a distribuição cronológica dos astros da Via Láctea

News Rondônia (in Portuguese - online)

Pesquisadores mapeiam a distribuição cronológica dos astros da Via Láctea

JINA-CEE Newsletter (online - Page 2)

Evidence for Multiple Progenitors of CEMP-no Stars

Space Daily (online)

Relics of the Milky Way's first generation of stars

University of Michigan News (online)

Relics of the Milky Way's first generation of stars

Notre Dame News (online)

Astrophysicists release new study of one of the first stars

Newswise (online)

Astrophysicists release new study of one of the first stars

EurekAlert! - AAAS (online)

Astrophysicists release new study of one of the first stars

Scientia (online - page 13)

Physics team creates Milky Way galaxy map

JINA-CEE Newsletter (online)

Discovery of the Brightest Ultra Metal-Poor Star

Agência FAPESP (in Portuguese - online)

Via Láctea cresceu de dentro para fora

Exame.com (in Portuguese - online)

Via Láctea cresceu de dentro para fora, diz pesquisa

Planeta Universitário (in Portuguese - online)

Via Láctea cresceu de dentro para fora

European Southern Observatory Photo Press Release (online)

ESO Telescopes Spy a Rare Relic

Notre Dame News (online)

Newly discovered star offers opportunity to explore origins of first stars in the early universe

Space Daily (online)

How the first stars sprung to life in early universe

Astronomy Now UK (online)

Ancient star provides insight into stellar origins in early universe

Empresa Brasil de Comunicação (in Portuguese - online)

História da Via Láctea ganha novos capítulos com descoberta de estrela por equipe da USP

Correio Braziliense (in Portuguese - online)

Astrônomos brasileiros identificam estrela rara na Via Láctea

Globo.com (in Portuguese - online)

Professor da USP descobre estrela tão antiga quanto o Universo

G1.globo.com (in Portuguese - online)

Astrônomos identificam estrela antiga e rara na Via Láctea

Agência USP de Notícias (in Portuguese - online)

Estrela traz evidências do início da Via Láctea

Universidade de São Paulo - Notícias (in Portuguese - online)

Equipe liderada pela USP identifica estrela chave para entender o início da Via Láctea

Agência FAPESP (in Portuguese - online)

Astrônomos brasileiros identificam estrela rara na Via Láctea

Folha de São Paulo (in Portuguese - online)

Astrônomos encontram uma estrela quase tão velha quanto o próprio Universo

JINA-CEE Newsletter (online)

Hubble Space Telescope Near-Ultraviolet Spectroscopy of Bright CEMP-s Stars

JINA-CEE Newsletter (online)

The First Age Map of the Galactic Halo

2015

Jornal da USP (in Portuguese - online)

Mapa permite estimar idade dos componentes da Via Láctea

UOL Notícias (in Portuguese - online)

Mapa permite estimar idade das estrelas da Via Láctea

Astronomy & Astrophysics Highlights (online)

2MASS J18082002-5104378: The brightest (V=11.9) ultra metal-poor star

The Observer (online and print)

Galactic archeologists create the first map of Milky Way's stellar halo

Best Education News (online)

Astrophysicists produce the first age map of the halo of the Milky Way

National Science Foundation - News from the Field (online)

Astrophysicists produce the first age map of the halo of the Milky Way

Notre Dame News (online)

Astrophysicists produce the first age map of the halo of the Milky Way

The Watchers (online)

The first age map of the Milky Way's halo produced

Red Orbit (online)

First-ever Milky Way age map shows oldest stars clustered in center

Headlines and Global News (online)

Milky Way Age Map Created For The First Time, Confirming Past Assumptions In Astrophysics

Global News Connect (online)

Astrophysicists furnish a initial age map of a Halo of a Milky Way

Sciece World Report (online)

First Ever Age Map of the Milky Way Galaxy Reveals History of the System

Media INAF (in Italian - online)

Quanto è vecchia la Via Lattea?

The Observer (online and print)

"Our Universe Revealed" lecture looks at chemical composition of stars

#### 2014

JINA-CEE Newsletter (online)

Seven New Stars with [Fe/H] < -3 - Six of them CEMP-no

Phys.org (online)

Galactic archaeologists uncover new insights into the formation of the earliest stars and galaxies