Nuclear Physics I: Nuclear Astrophysics

PHYS 8801

Alexander Heger[1]

[1]Minnesota Institute for Astrophysics
School of Physics and Astronomy
University of Minnesota

Nuclear Physics I: Nuclear Astrophysics, Spring 2012

Agenda

1. Welcome
   - Overview
   - Course Administration
   - Prerequisites
   - Course Topics
2. Introduction
   - Origin of the Elements
   - Composition of Earth

Overview

Target Audience and Class Content

- This series is a modern course covering current topics of Nuclear Physics, in particular Nuclear Astrophysics (8801) and Finite-Temperature Field Theory (8802).
- It has less emphasis on some of the classical nuclear physics theory such as nuclear structure.
- This course can be considered an advanced version of continuation of AST-4001 and we anticipate it will be cross-listed as 8000 Stellar Astrophysics in Astronomy.
- The goal of this course is to give a thorough overview of the field of Nuclear Astrophysics from microscopic physics input to macroscopic astrophysical environments with special emphasis on nucleosynthesis and neutrinos.

Textbooks

- **Christian Iliadis:**

  Nuclear Physics of Stars
- **Kippenhanh & Weigert:**

  Stellar Structure and Evolution

Course requirements

- Will use Stellar Evolution Code `MESA` to do course projects (homework)
- A small set of other homework problems
- Project write-up on evolution study or literature project

Contact

- **Location & Dates:**
  Physics 157, T 9:00-10:00 A.M. Physics 157, Th 9:00-10:30 A.M.
- **Office hours:**
  TBD, 342F Tate
- **email:**
  alex@physics.umn.edu
- **Web site:**
  `http://stellarevolution.org/PHYS-8801`
  probably we can do things by e,ail instead
- **Google course calendar** (on Web site):
  `(will set up)`

Topics

1. 5001/5002 Quantum Mechanics
2. 5011/5012 Classical Physics
3. 5201 Thermal and Statistical Physics
4. AST-4001 (recommended)

Topics

1. Thermonuclear Reactions
   - nuclear physics background
   - specific reactions relevant to nuclear astrophysics
2. Stellar Evolution
   - stellar structure and evolution
   - nuclear burning phases
   - low-mass and massive star evolution

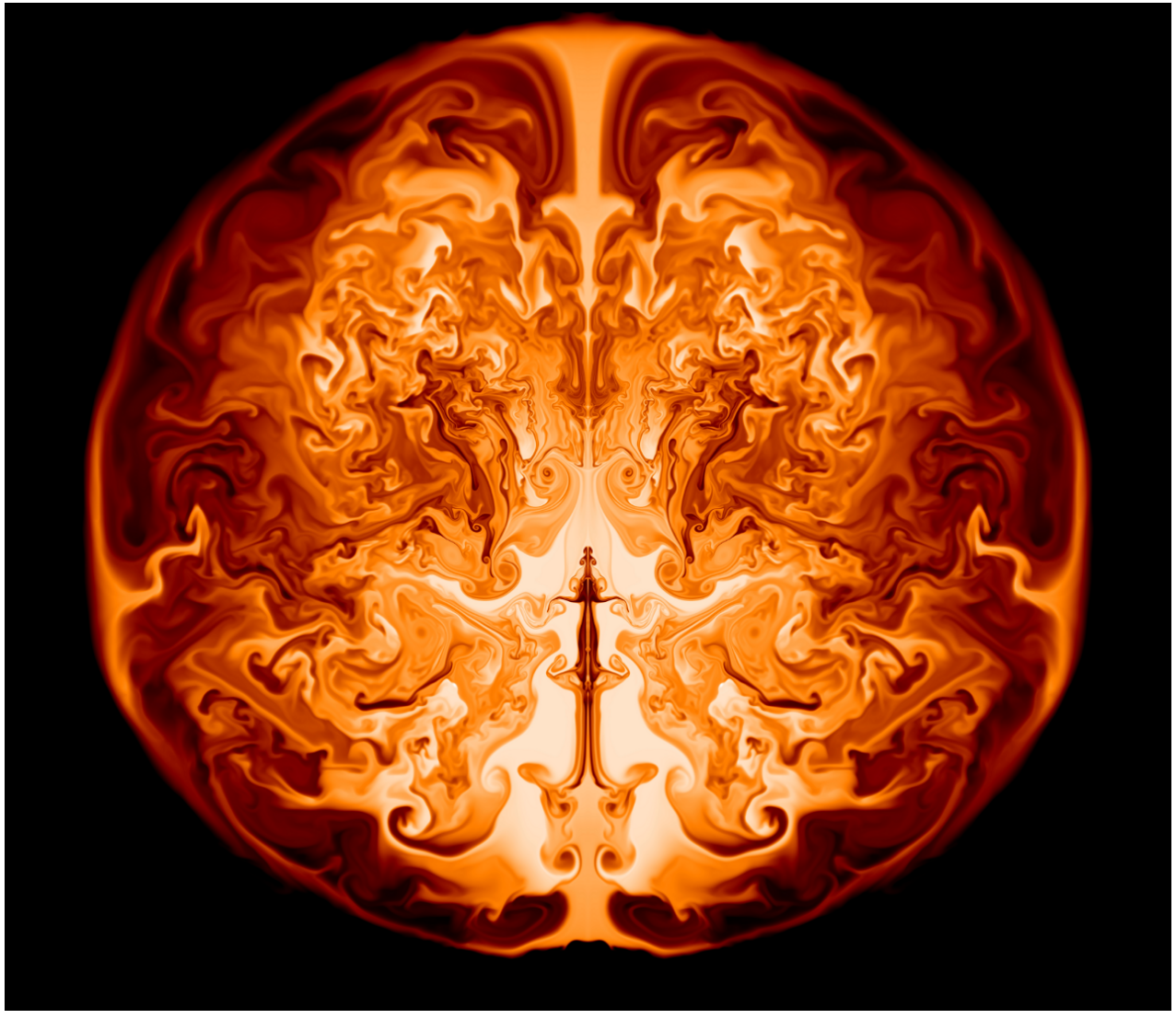
Topics (continued)

3. Supernovae
   - types and mechanisms
   - nucleosynthetic processes
4. Neutrino Astrophysics
   - neutrinos and big bang nucleosynthesis
   - solar neutrinos
   - supernova neutrinos
   - neutrino oscillations

Topics (continued)

5. Nucleosynthesis beyond the Fe Peak
   - s- and r-processes
   - p- and nu-p-processes
6. Galactic Chemical Evolution
   - overview of the origin of the elements
   - observations
   - models
7. Exotic stars
   - neutron star physics
   - novae, X-ray bursts and other transients

A Supermassive Star



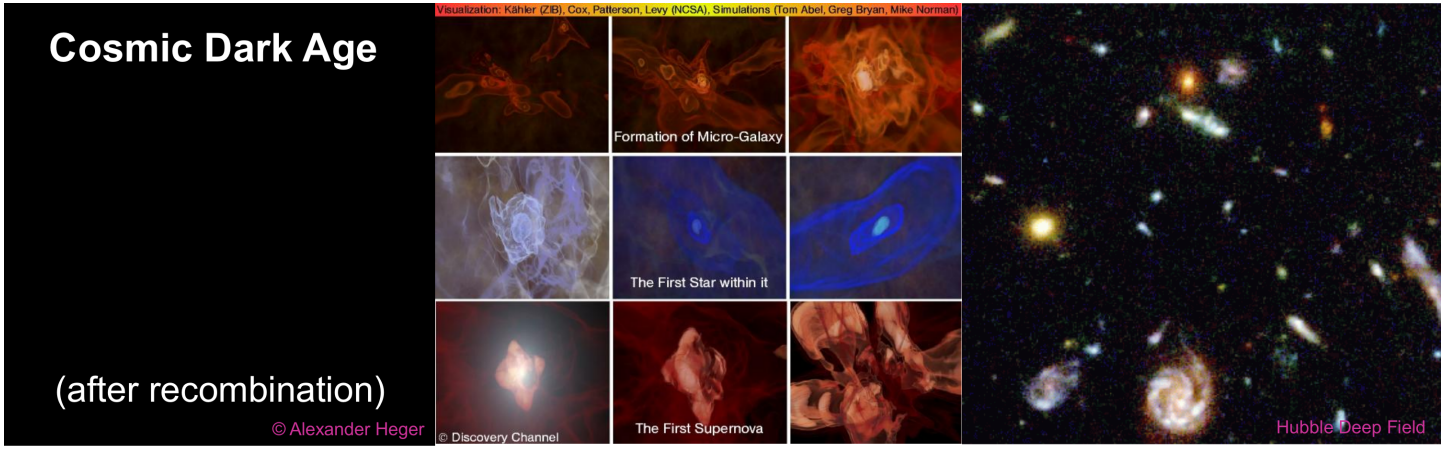
Class Project - Stellar Evolution Topics

- Evolution of the Sun (vary input physics)
- Stars and nuclear reaction rates
- Stars and what they are made of
- helium stars
- your suggestion

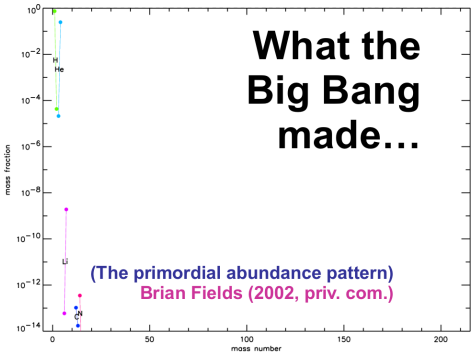
Overview

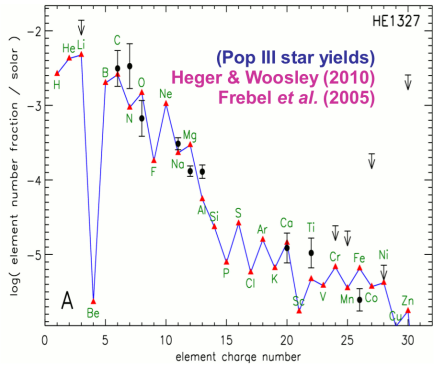
The Origin of the Elements

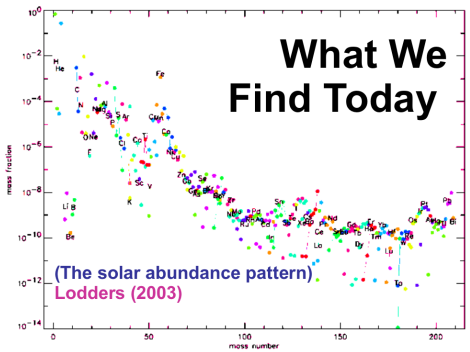
The Origin of the Elements



time







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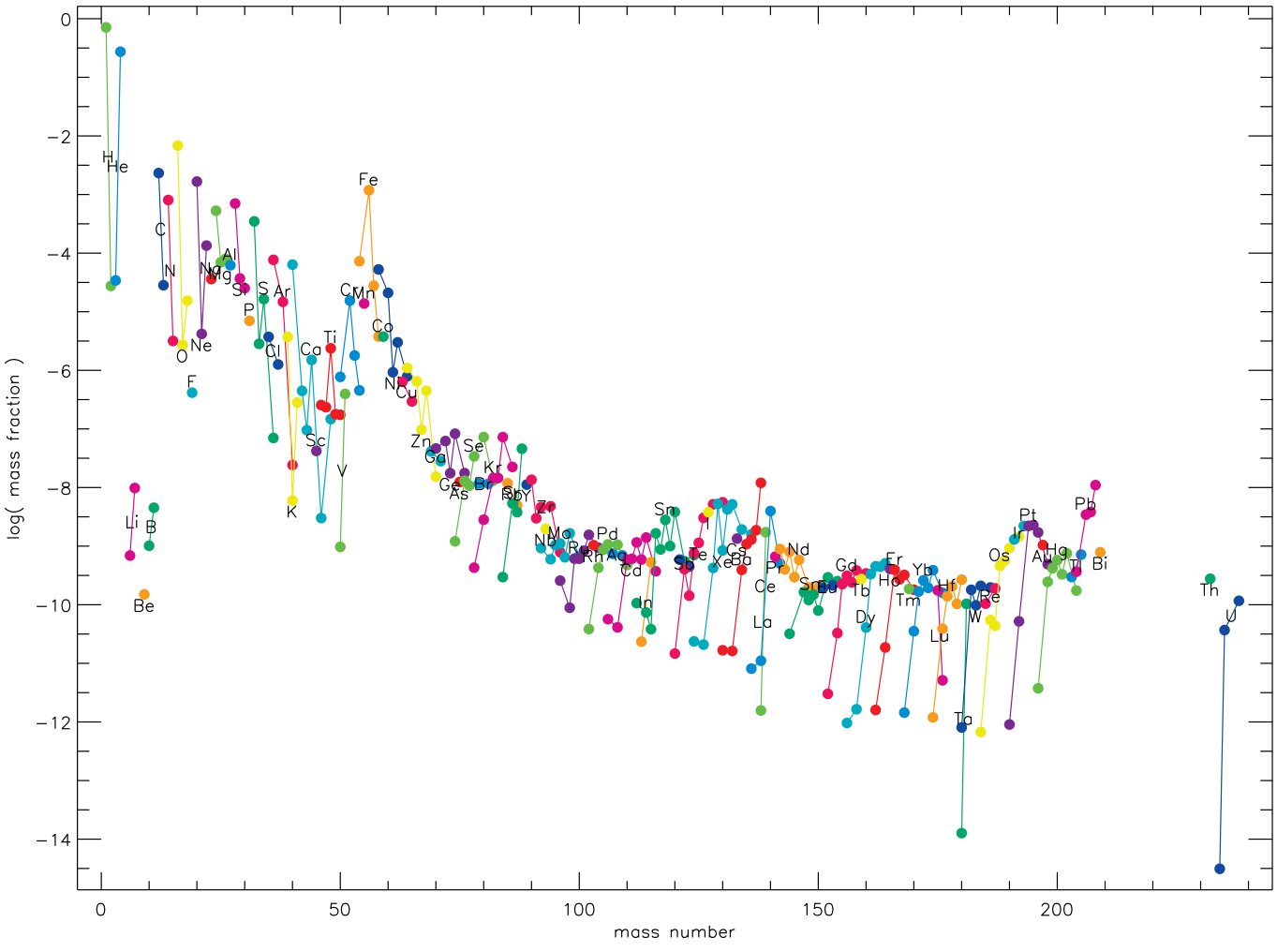

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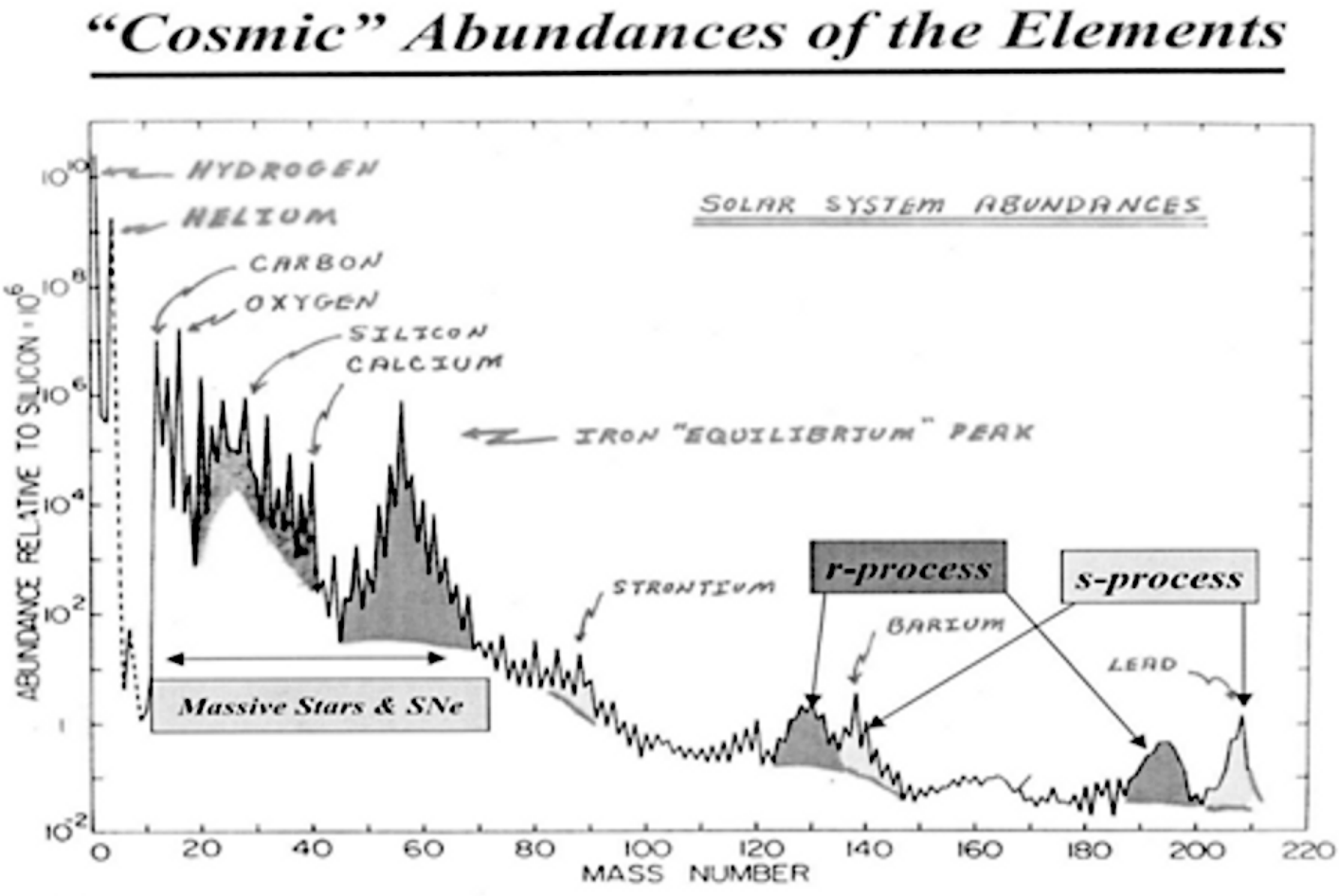
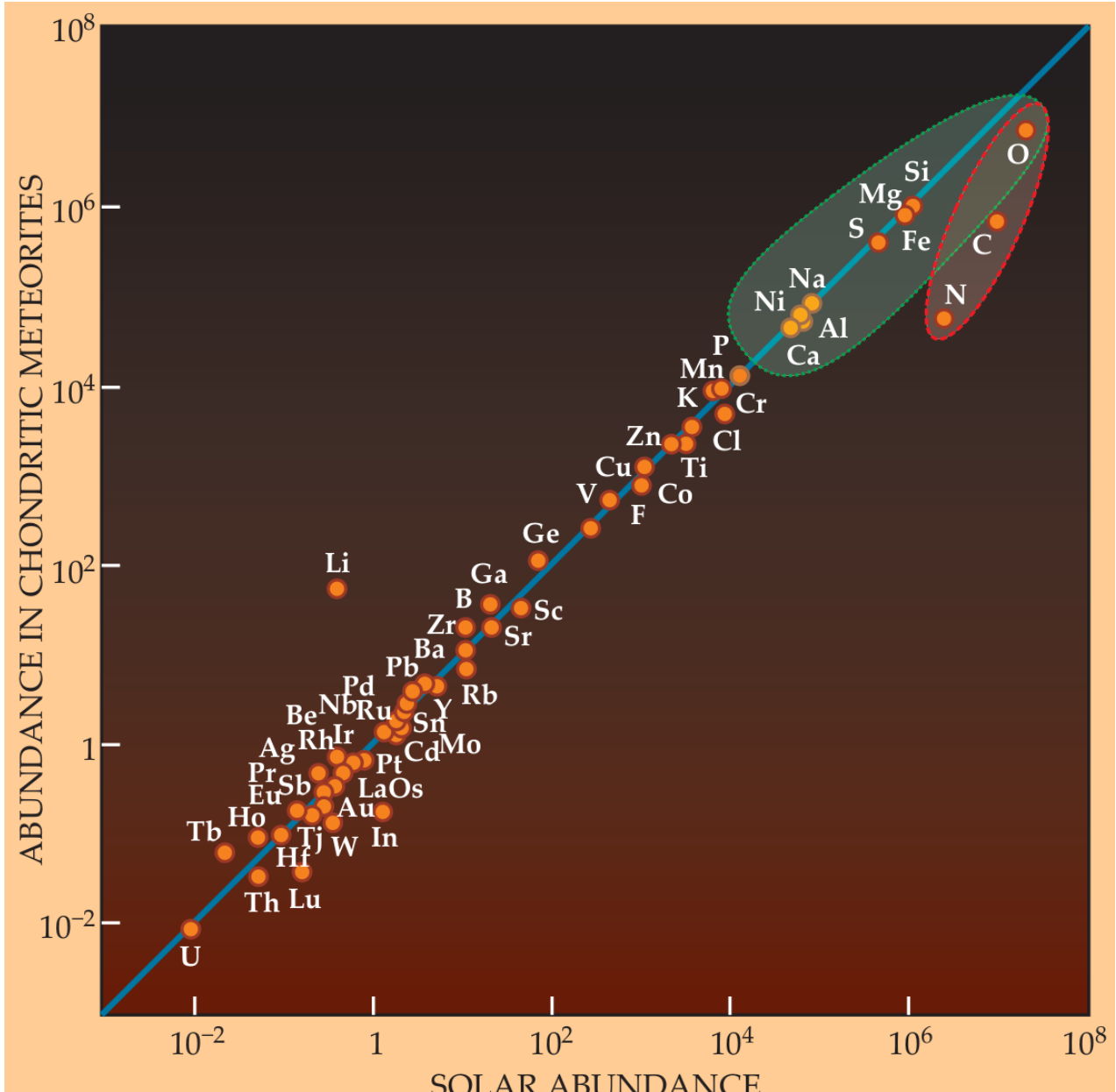


Composition of Solar System



Composition of Earth