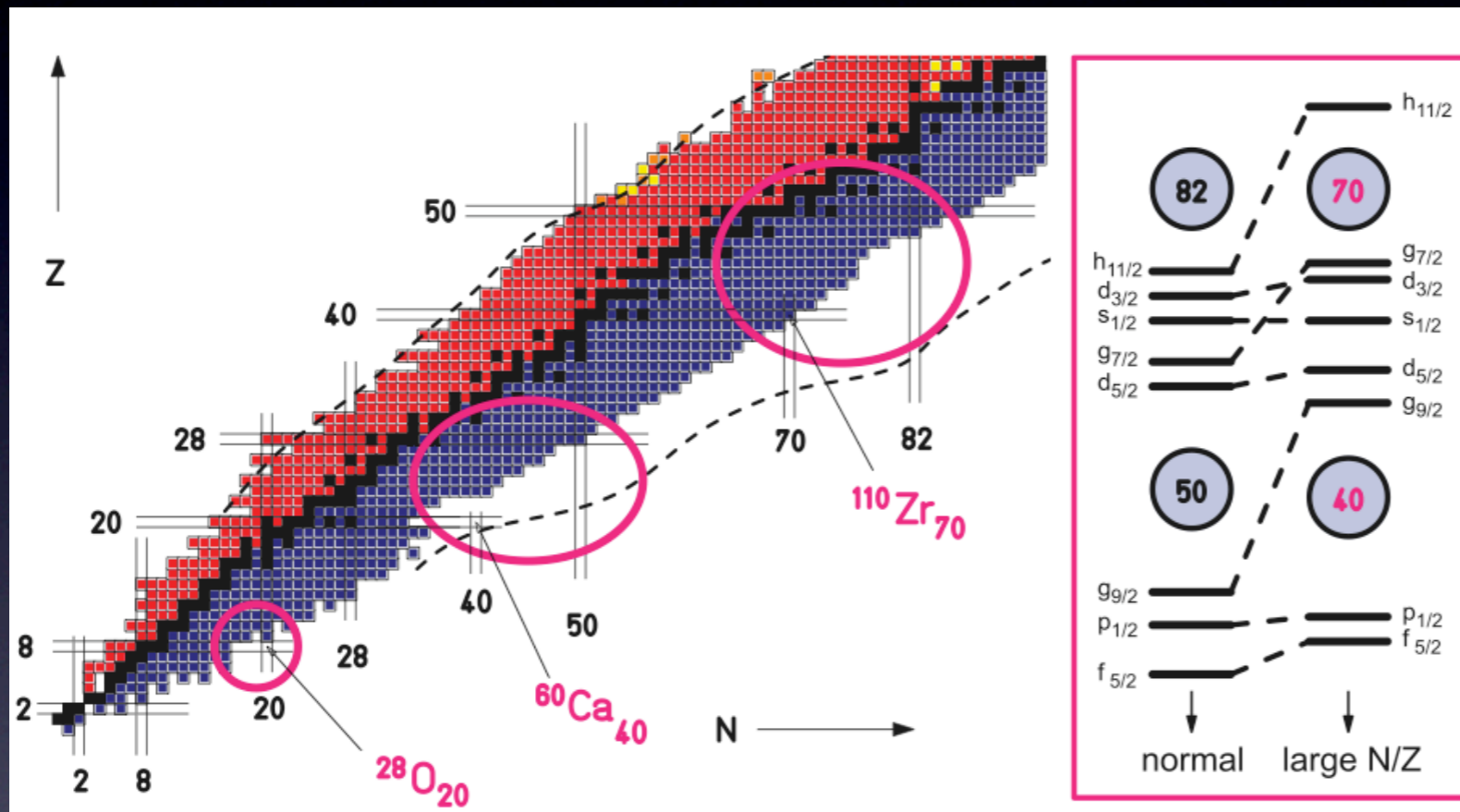# Science with KoRIA

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Pohang, Nov. 15, 2008

Overview

- Nuclear Structure

- Nuclear Astrophysics

- Fundamental Symmetries

- Other Applications

- Summary

Nuclear Structure

- Probing the disappearance of shell structure

- Is shell model still valid in neutron rich nucleus?

- Neutron rich, double magic nuclei

  - ^{56}Ni, ^{78}Ni, ^{100}Sn, ^{132}Sn

Pairing & Superfluidity

- Pairing of fermions in neutron (or proton) rich environment

- Understand the cooling of the neutron stars

- Two nucleon transfer studies on various nuclei

Collective Motion
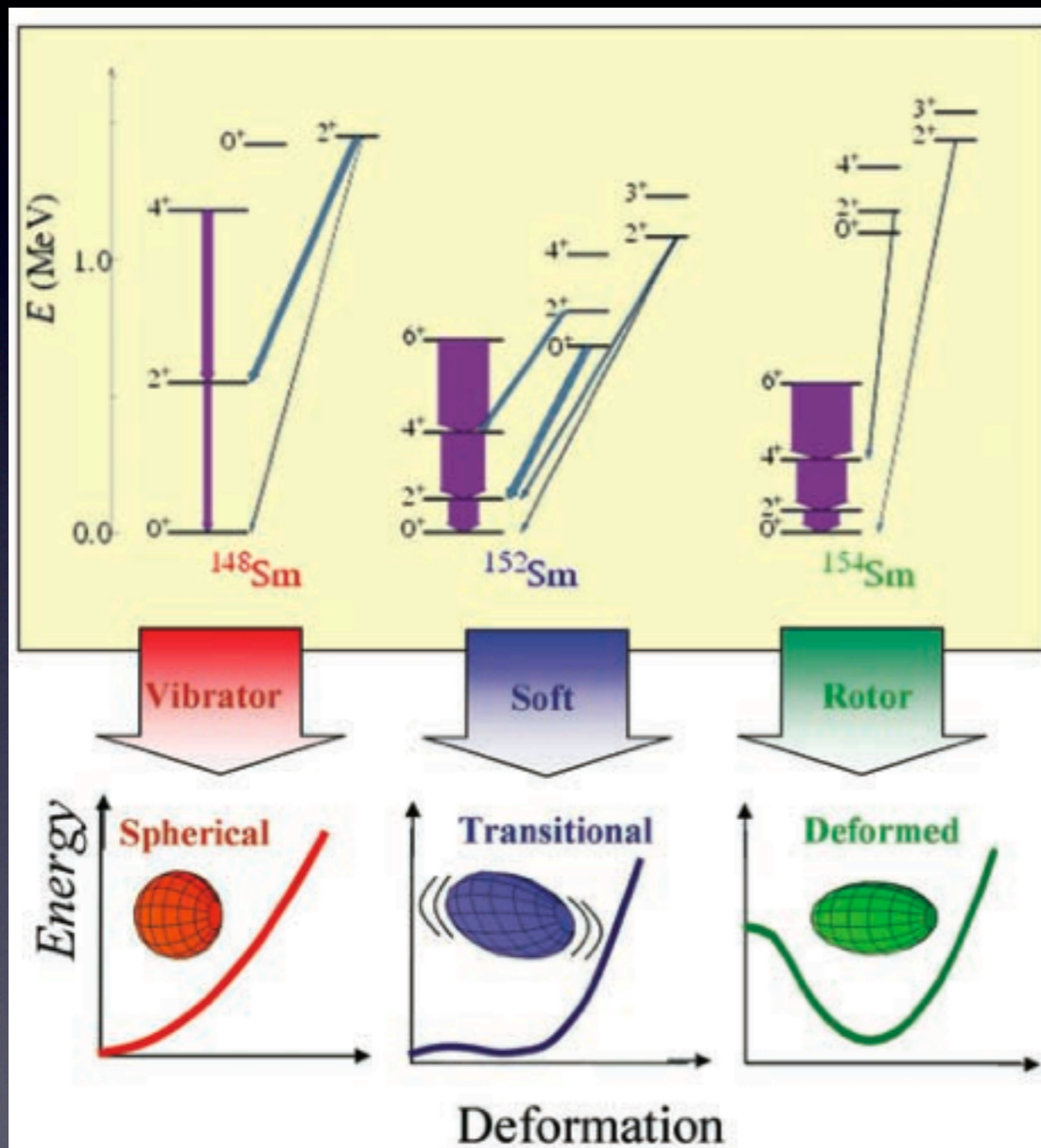
- The evolution of collective motion in complex nuclei

  - Deformation from spherical nucleus

  - Collective behavior of exotic nuclei

Neutron Skins, Halos

- Nuclei near the neutron drip line

  - Model for the exotic neutron-rich environment of neutron stars

- Discovery of new collective modes

  - low energy iso-vector vibrational mode

  - may change neutron-capture cross sections - affect r-process
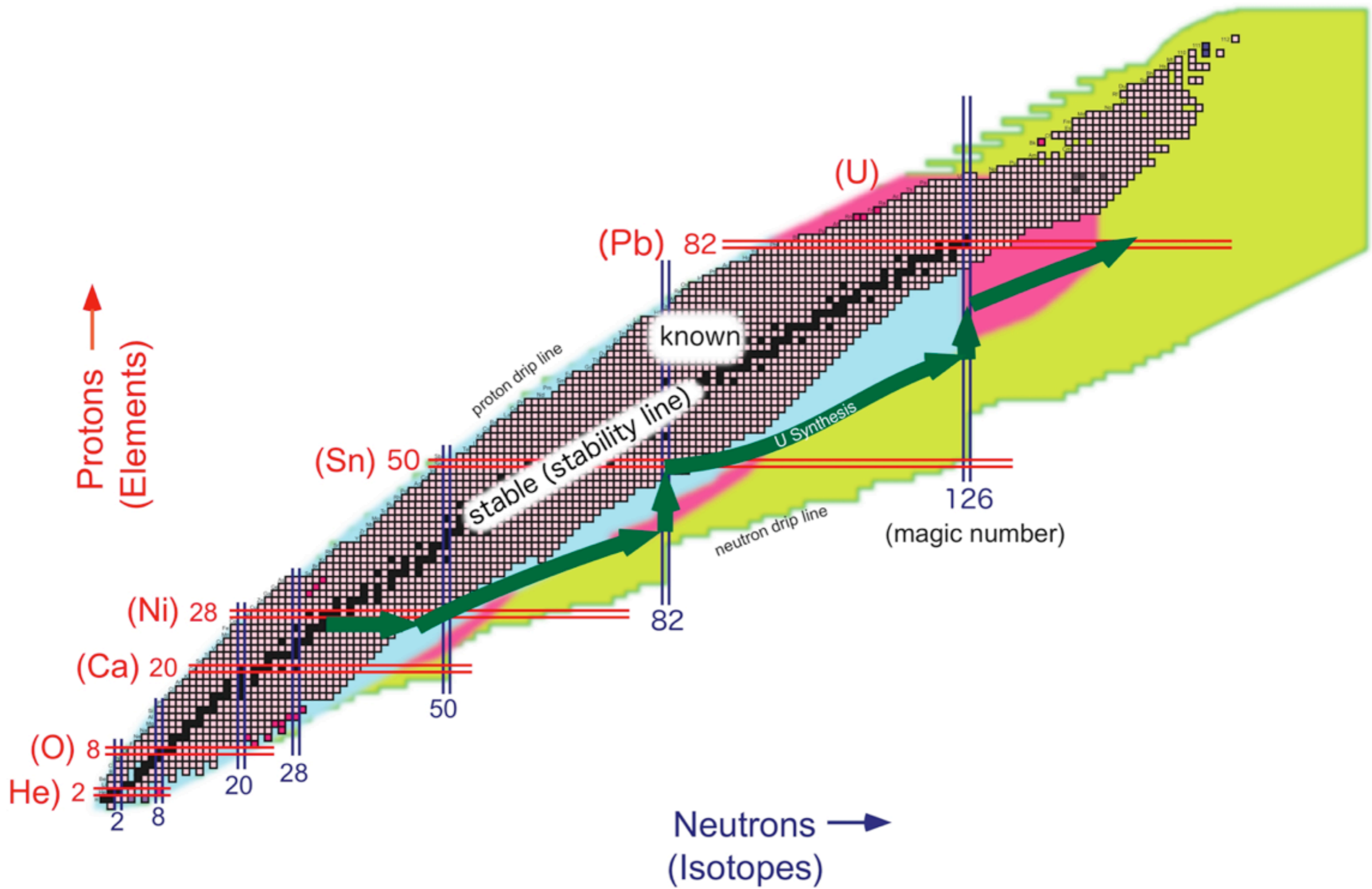
New Elements
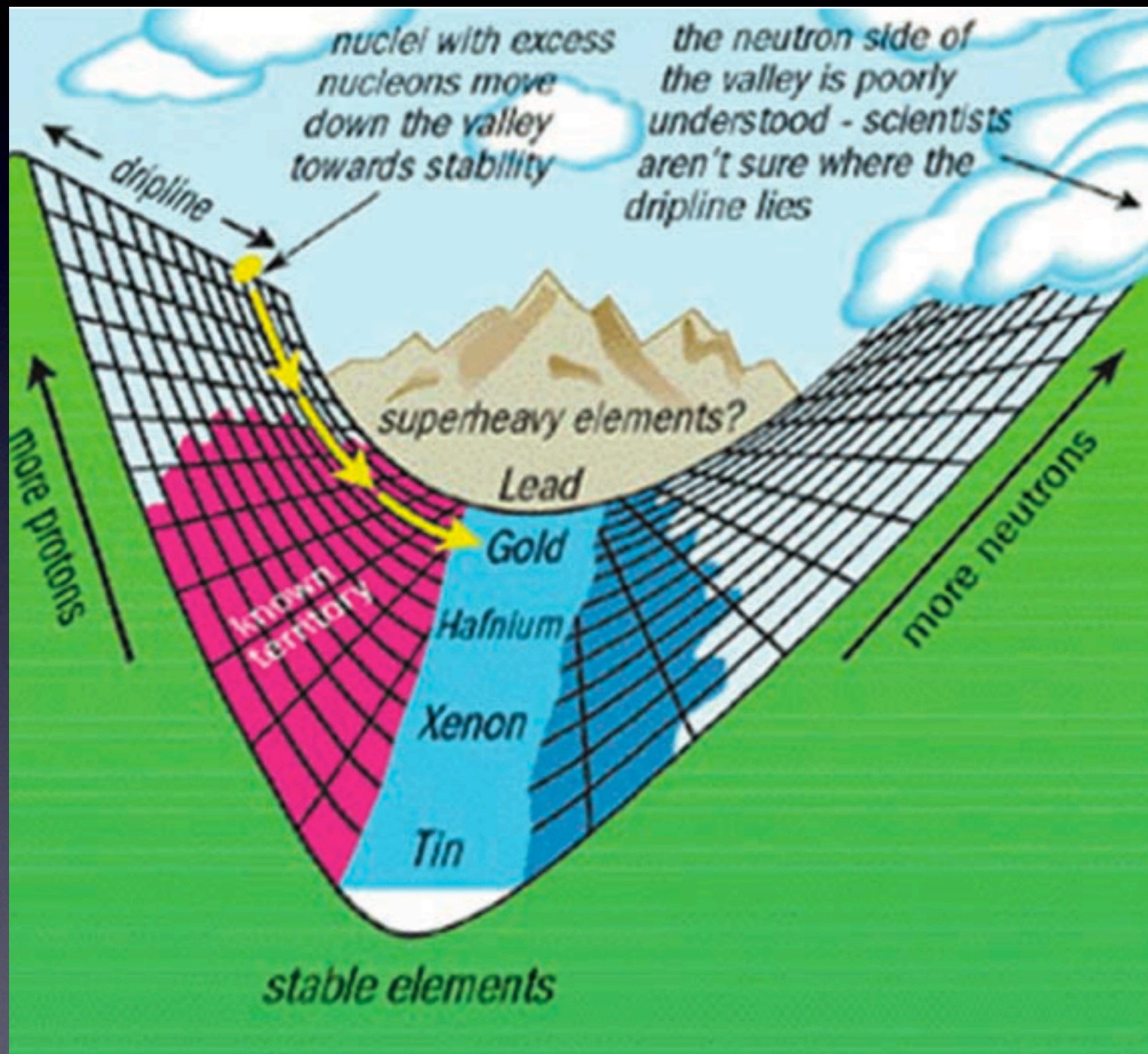
- Production and Naming
  - Koreanium project

Nuclear Astrophysics

- Origin of Elements

- Explosive processes in the universe

- Composition of neutron stars

Origin of Elements

- Formation of the elements from C to U

  - Stars, novae, x-ray bursts & supernovae

- Calculation of supernova

 - About 1500 isotopes involved, 10% of them stable

Nuclear Data

- About 15,000 possible reactions

  - $n, p, \alpha, \gamma, \nu$ in entrance and exit channel

    - Large volume of nuclear data required

    - The most critical ones to be measured

Explosive Nucleosynthesis

- r-process
  - rapid neutron capture
    - merging binary pair of neutron stars
    - neutrino powered wind in supernova explosion
  - formation of neutron rich elements
  - critical information
    - BE, β lifetime, n-capture σ
    - formation of "waiting point"
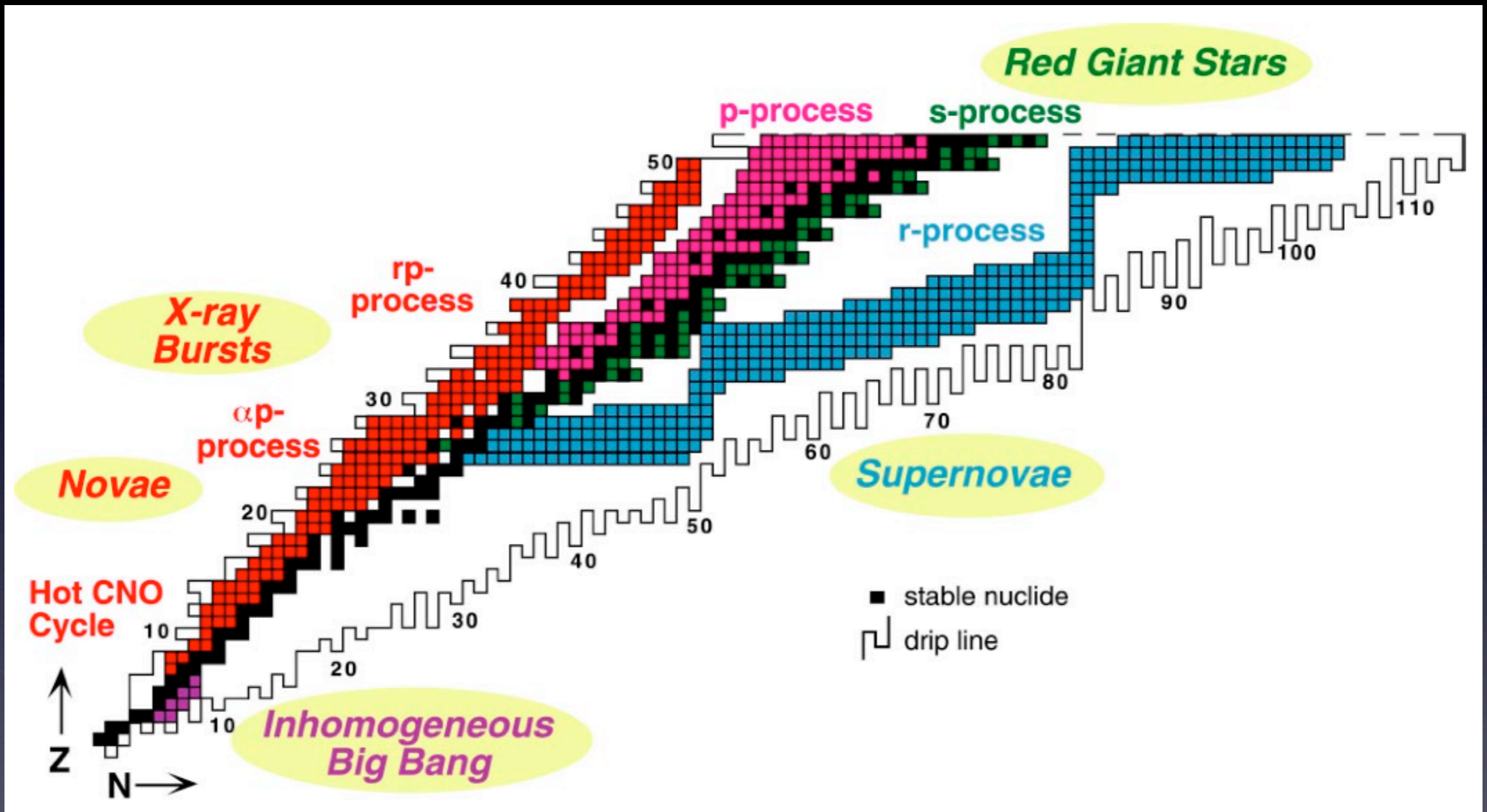
Other Processes

- rp-process
  - rapid proton addition
  - neutrino powered wind in supernova explosion
  - X-ray burst
- gamma-process

Neutron Stars
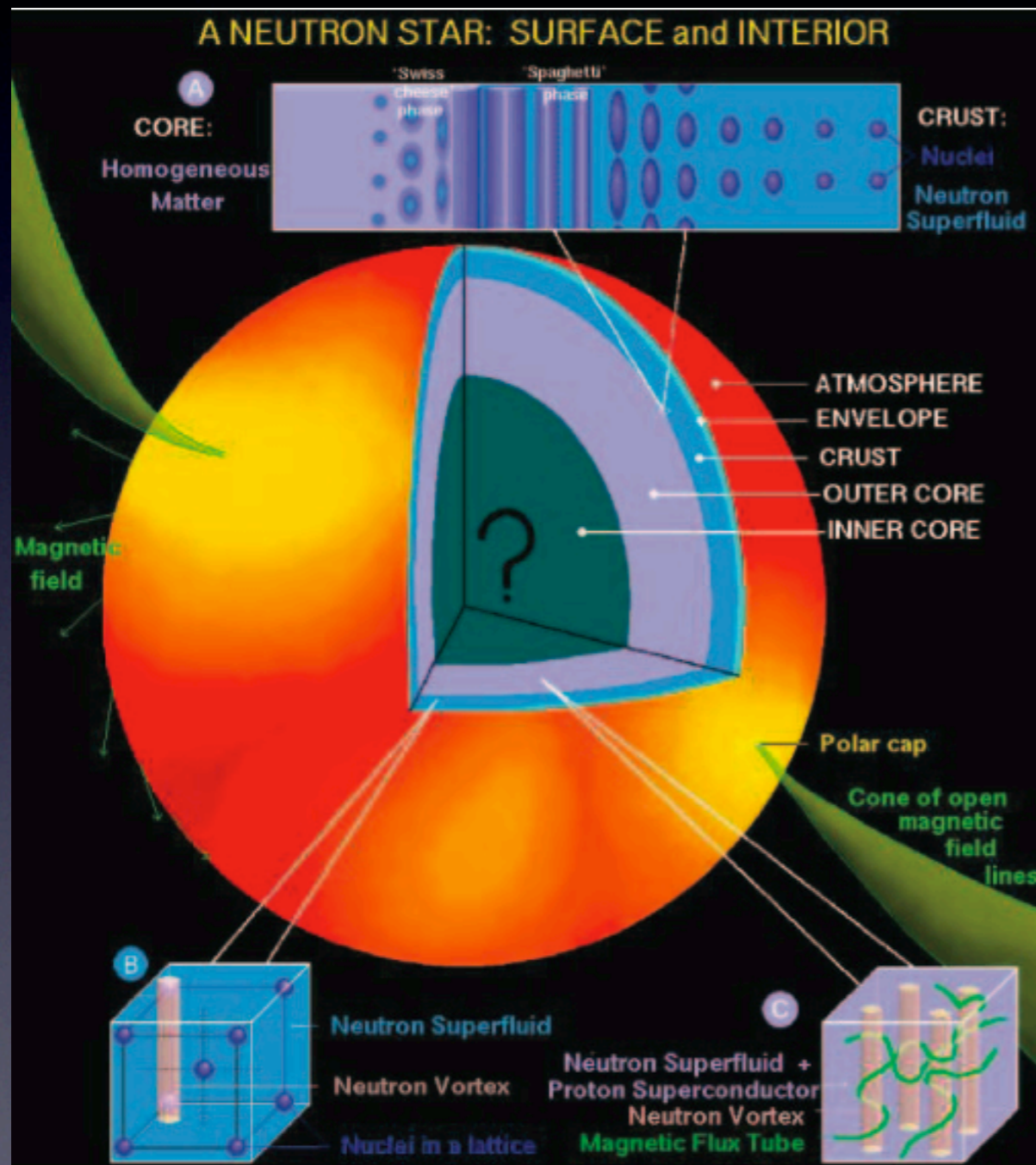
- Equation of State for neutron rich nuclei

Specific Examples

- BE, lifetime, σ for nuclei along r-process line

- BE, lifetime, σ for nuclei along rp-process line

- Cross sections for the production of potential targets for gamma-ray astronomy

  - ^{22}Na, ^{26}Al, ^{44}Ti, ^{56,57}Co, ^{60}Fe

- Charge-exchange reactions on unstable nuclei in the iron group

Examples (cont.)

- p & α capture cross sections on heavy proton-rich nuclei up to lead

- Cross sections for a large variety of nuclear reactions to calibrate parameters of theories

- n-capture cross sections along the path of the s-process

Fundamental Symmetries

- Search for non-zero EDM

  - Evidence for CP or T symmetry violation

  - Enhanced effect of CP-violating interactions

    - ^{229}Pa, ^{223}Ra, ^{225}Ra, ^{223}Rn

    - Production of the isotopes and measurement of EDM

Other Applications

- Stockpile stewardship

- Materials science

- Medical research

- Nuclear reactors

Required Specifications

- High power linear accelerator

  - 200 MeV, 400 kW

  - Superconducting linac

  - 200 MeV/u for heavy ions (600 MeV proton)

  - ECR ion source, RFQ at room temp.

Summary

- Nuclear Structure

  - Expand into neutron or proton rich exotic nuclei

- Nuclear Astrophysics

  - Origin of heavy elements

  - Search for new elements

  - Explosive processes in the universe

Summary

- Fundamental Symmetries

  - New enhanced way to search for EDM

- Other Applicaitons

  - Green science and technology

  - Materials science

  - Medical science

Dream High

- Emerging field

- High potential for new discoveries

- Boost the basic research in Korea