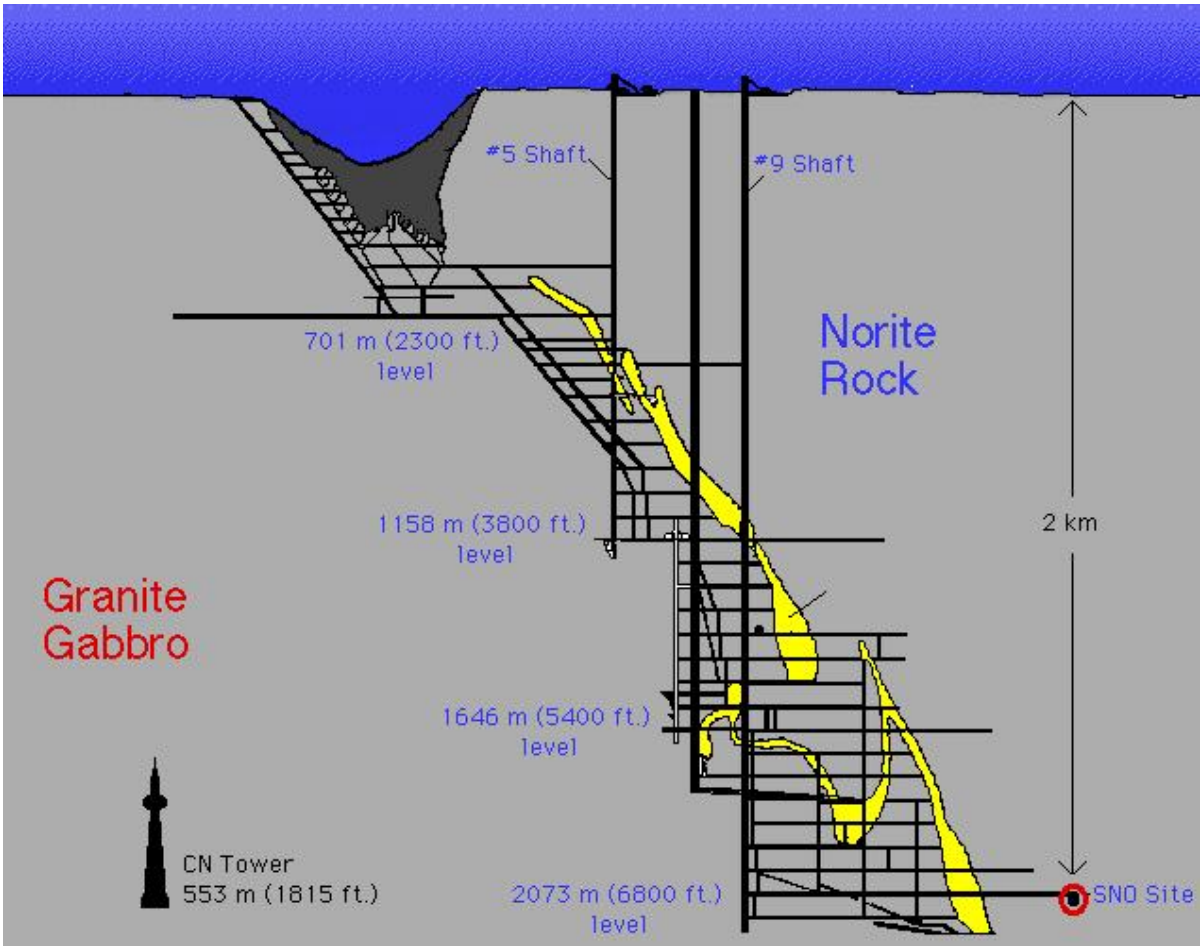
Lecture 28 : The case of the missing neutrinos

This lecture is about a most remarkable 'detective story'. The relentless hunt for the missing neutrinos from the Sun. In August 1920, Sir Arthur Eddington made the remarkable suggestion that the energy radiated by the sun and the stars is produced when Hydrogen is transmuted to Helium - the deficit mass is radiated away as energy. The details of this fusion of hydrogen to helium was worked out by Hans Bethe in 1938. If it is true that the sun is converting hydrogen into helium, then the sun must be emitting 10^{38} neutrinos per second; and a good fraction of this must pass through the earth. Raymond Davis, a very brave chemist, decided to build a detector to 'detect' the solar neutrinos. By 1968, he had succeeded. But there was a twist. The 'number' of neutrinos he detected was just one third of what was expected. Thus began the hunt for the missing neutrinos. And it took more than 30 years to solve this mystery - and it was solved! This lecture tells the remarkable story of the missing neutrinos.



On many occasion Astrophysics has played a pivotal role in changing the direction of fundamental physics. The problem of the 'missing' solar neutrinos has been one such. It took more than four decades to 'solve' the problem and the Sudbury Neutrino Observatory (SNO) has been instrumental in it. The picture above is an artist's conception of the SNO detector, built 6800 feet underground, in VALE's Creighton mine near Sudbury, Ontario, Canada. [Picture Credit : SNO Homepage]

11 November 2022

Astronomy & Astrophysics : An Introductory Survey

A lecture series by Prof. G. Srinivasan

A 'Golden Jubilee Celebration' Event of the Astronomical Society of India

Lecture 28 : The case of the missing neutrinos

[Supplementary Material : Dr. Sushan Konar]

Suggested Reading

1. *Particle Physics : Popular Exposition*

   P. B. Pal (*translated by S. Konar*), 2014, **At the root of things**, CRC Press

2. *Particle Physics : Text Book*

   (a) D. Griffiths, 2008, **Introduction to Elementary Particles**, Wiley

   (b) P. B. Pal, 2014, **An Introductory Course of Particle Physics**, CRC Press

3. *Solar Neutrino Problem : Popular / Semi-Popular / Technical Articles*

   (a) J. N. Bahcall, New Scientist, Augutst, 1992
   High noon for solar neutrinos

   (b) P. B. Pal, 1992, IJMPA, 07, 5387
   Particle Physics confronts the Solar Neutrino Problem

   (c) H. Prosper, 2000, Pramana, 54, 611
   The solar neutrino problem

   (d) J. N. Bahcall, 2004, Nobel Prize Outreach AB 2022
   Solving the mystery of the missing neutrinos

   (e) A. B. McDonald, D. L. Wark, J. R. Klein, Scientific American, January, 2006
   Solving the Solar Neutrino Problem

11 November 2022