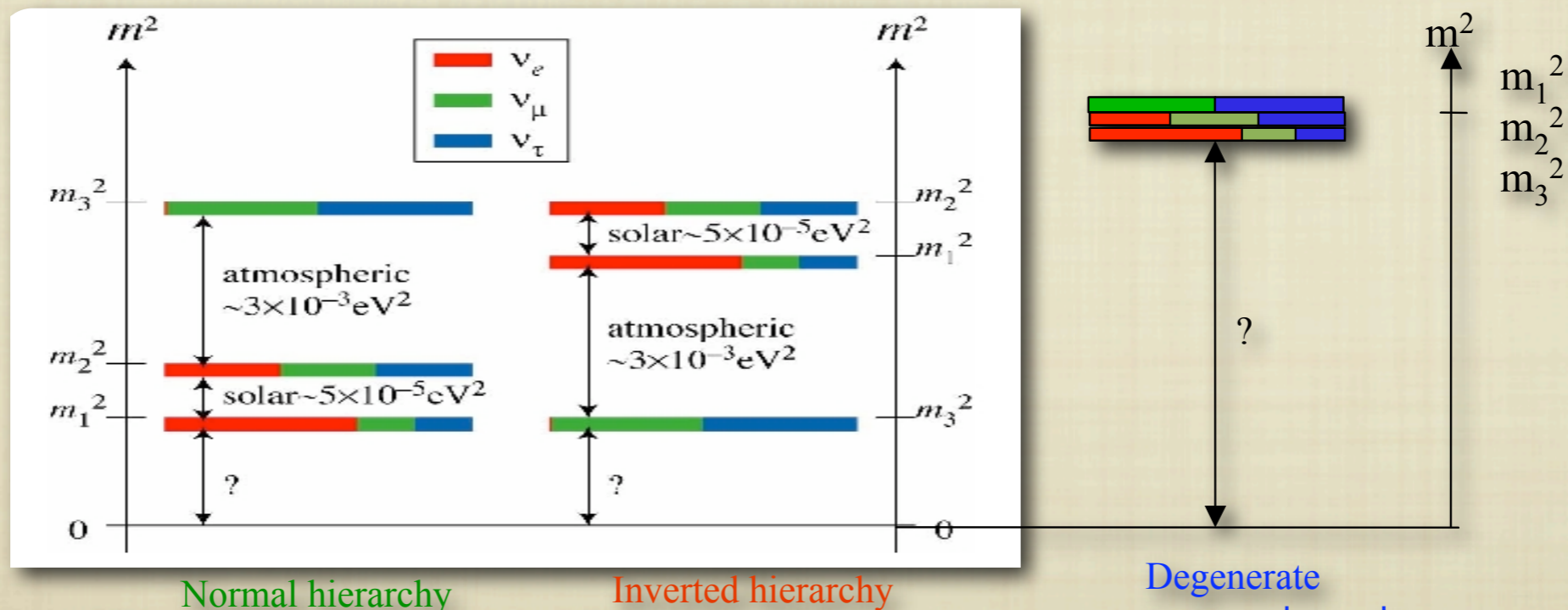
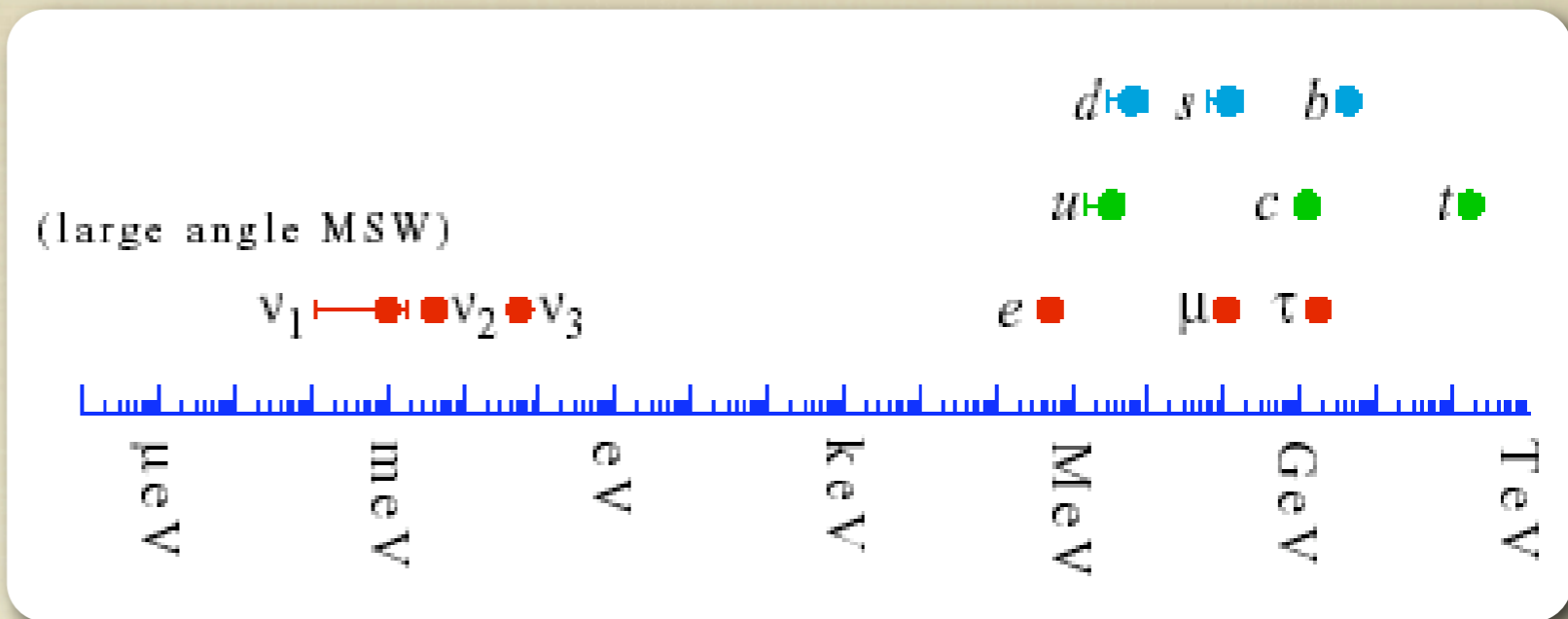
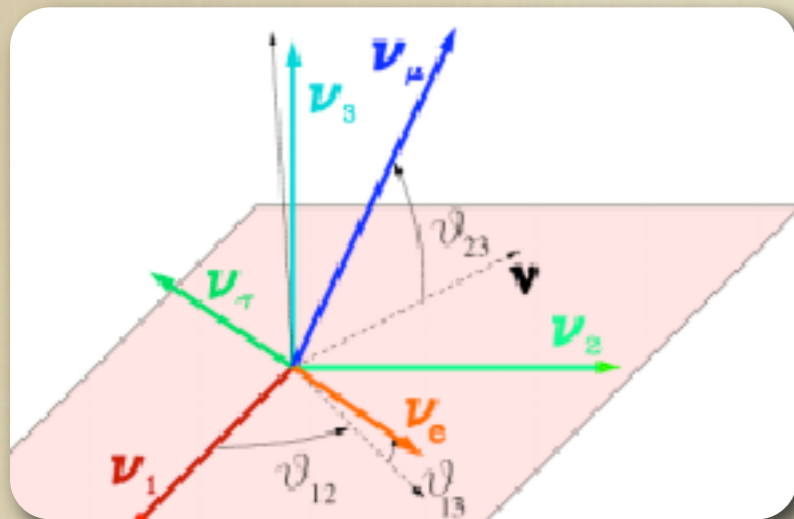


HUNDRED BILLION (V)



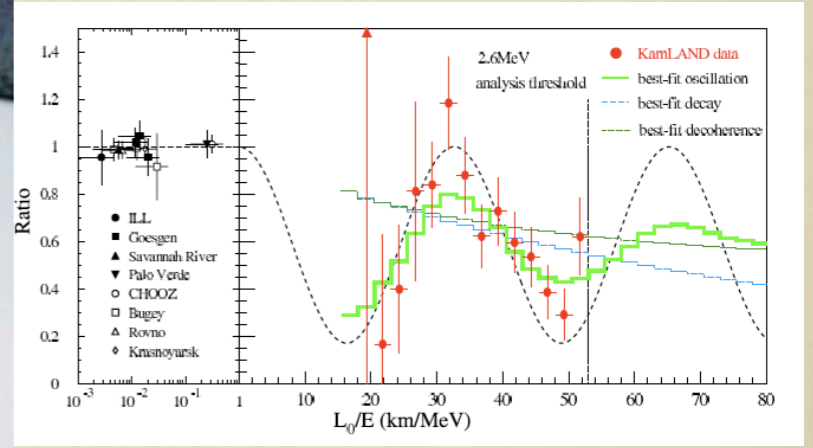
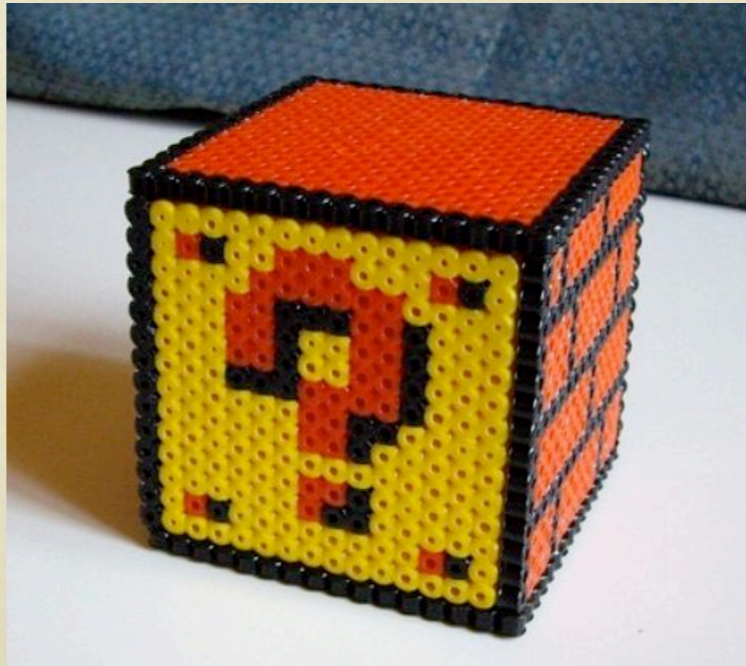
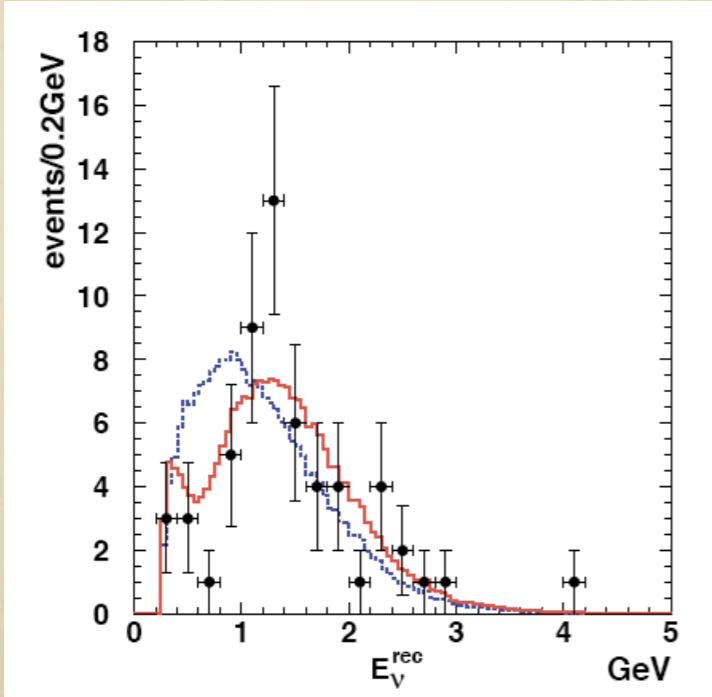
J.J. GÓMEZ CADENAS
IFIC-CSIC-U.VALENCIA
CERN SUMMER STUDENT LECTURES
2008

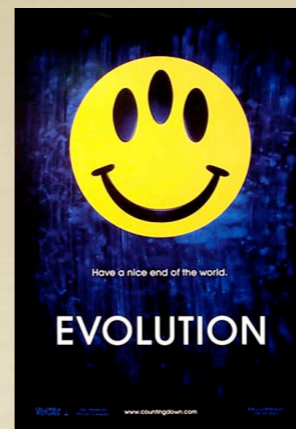
THE NEUTRINO PICTURE



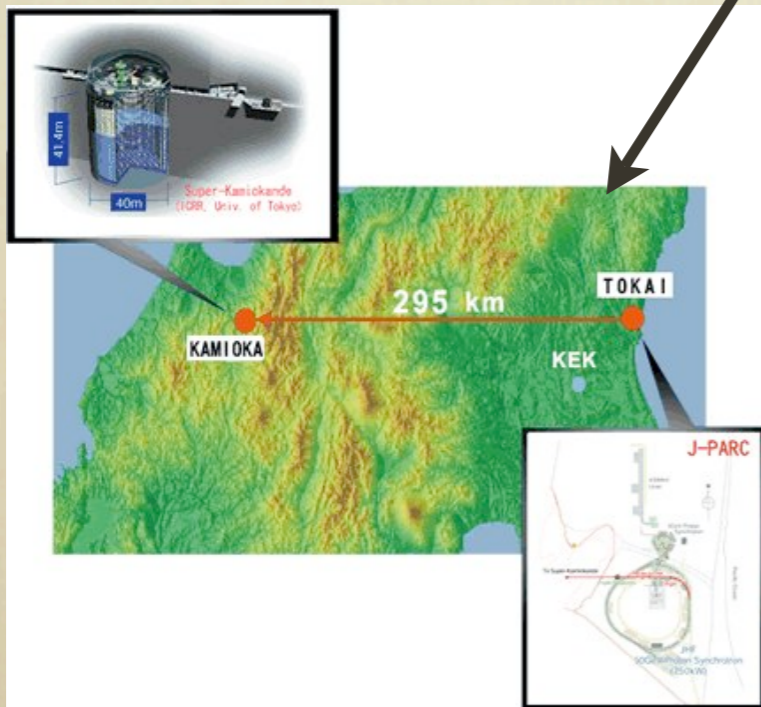


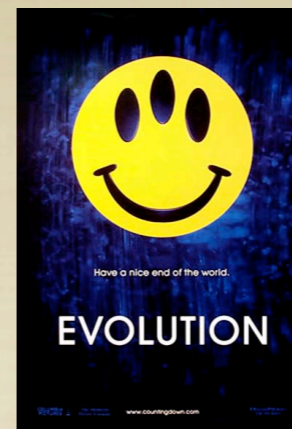
$$U = \begin{pmatrix} 1 & 0 & 0 \\ 0 & c_{23} & s_{23} \\ 0 & -s_{23} & c_{23} \end{pmatrix} \begin{pmatrix} c_{13} & 0 & s_{13}e^{\delta} \\ 0 & 1 & 0 \\ -s_{13}e^{\delta} & 0 & c_{13} \end{pmatrix} \begin{pmatrix} c_{12} & s_{12} & 0 \\ -s_{12} & c_{12} & 0 \\ 0 & 0 & 1 \end{pmatrix}$$



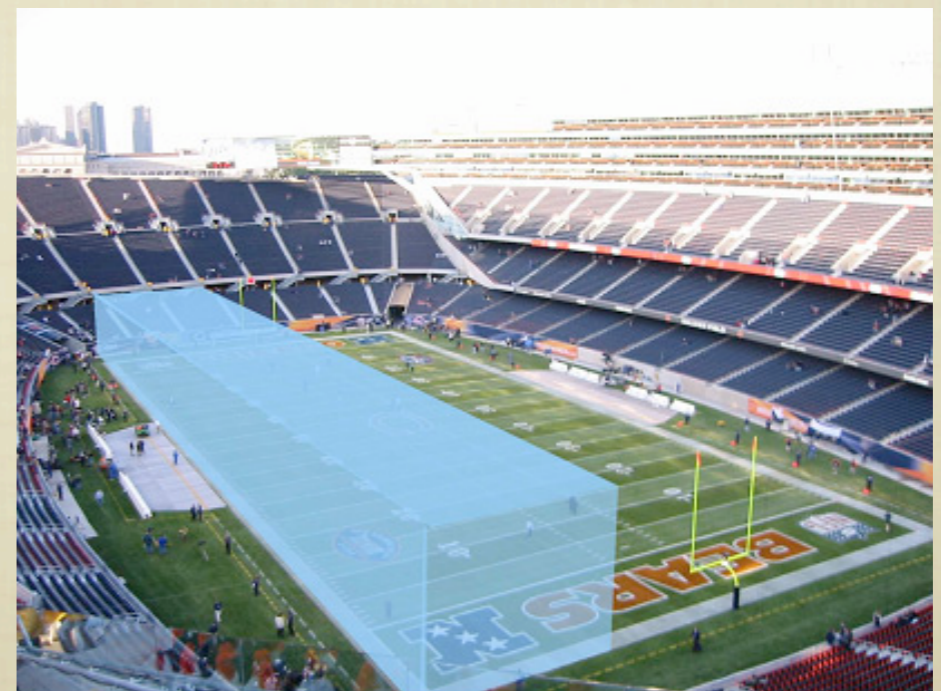
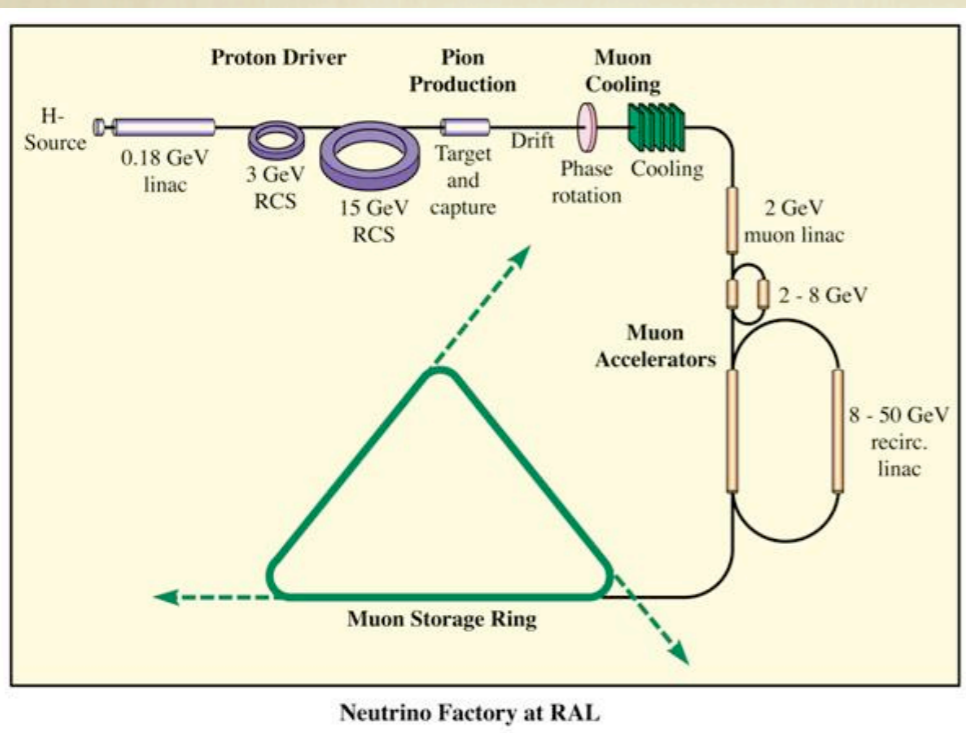


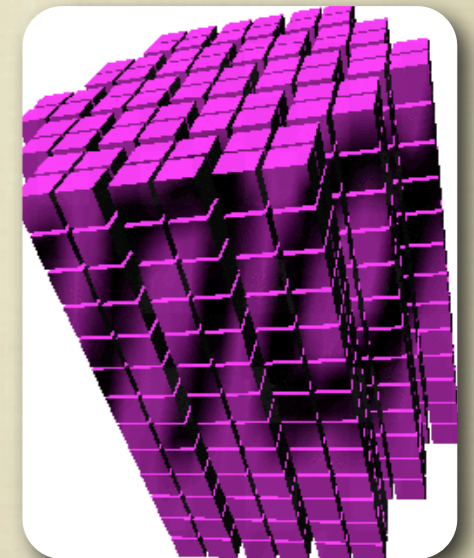
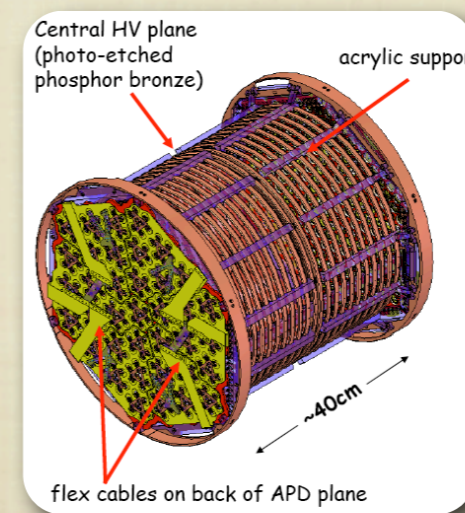
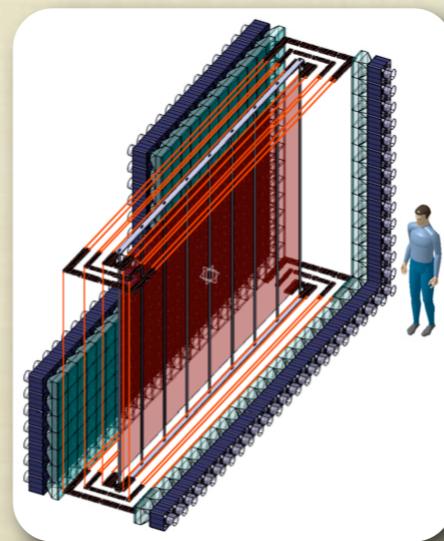
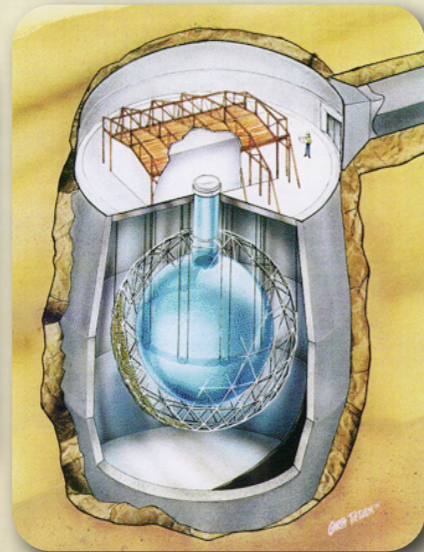
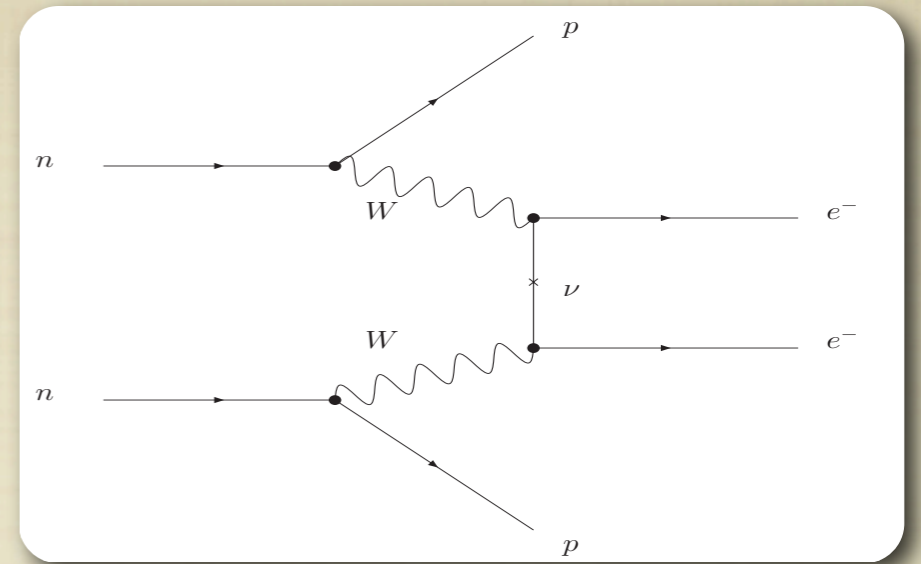
$$U = \begin{pmatrix} 1 & 0 & 0 \\ 0 & c_{23} & s_{23} \\ 0 & -s_{23} & c_{23} \end{pmatrix} \begin{pmatrix} c_{13} & 0 & s_{13}e^{\delta} \\ 0 & 1 & 0 \\ -s_{13}e^{\delta} & 0 & c_{13} \end{pmatrix} \begin{pmatrix} c_{12} & s_{12} & 0 \\ -s_{12} & c_{12} & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

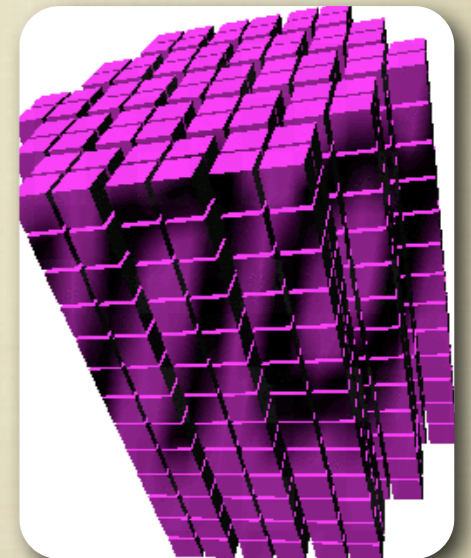
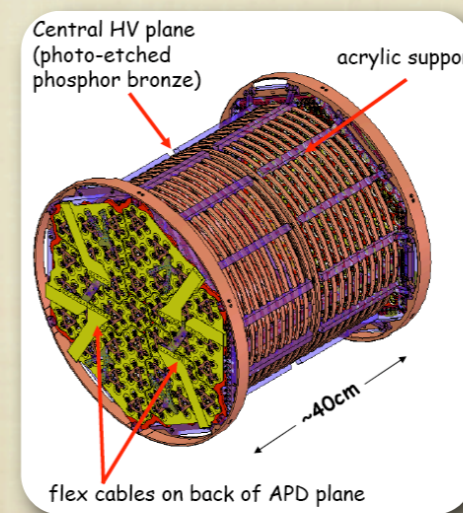
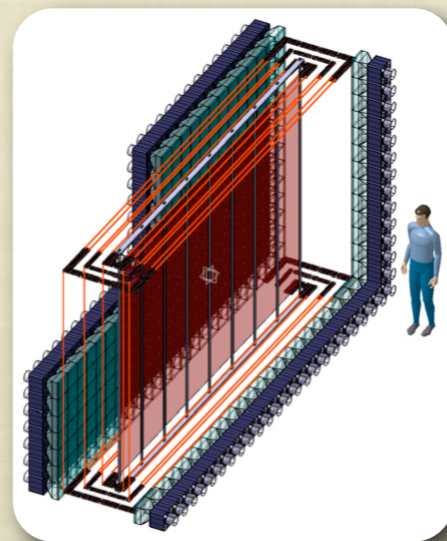
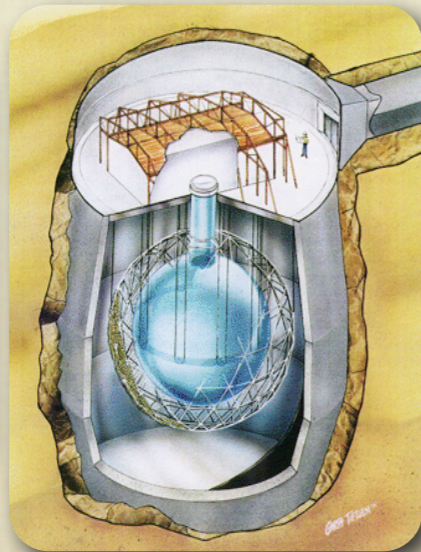
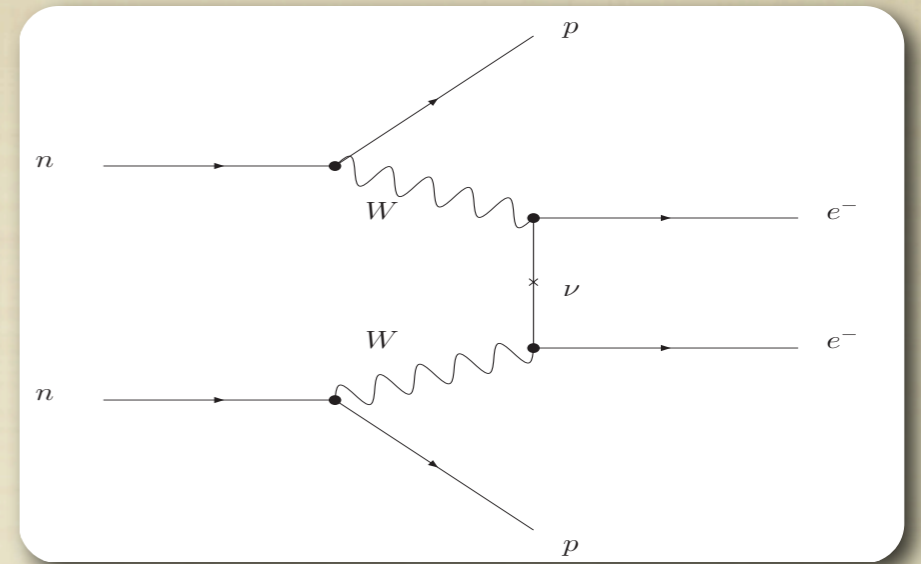
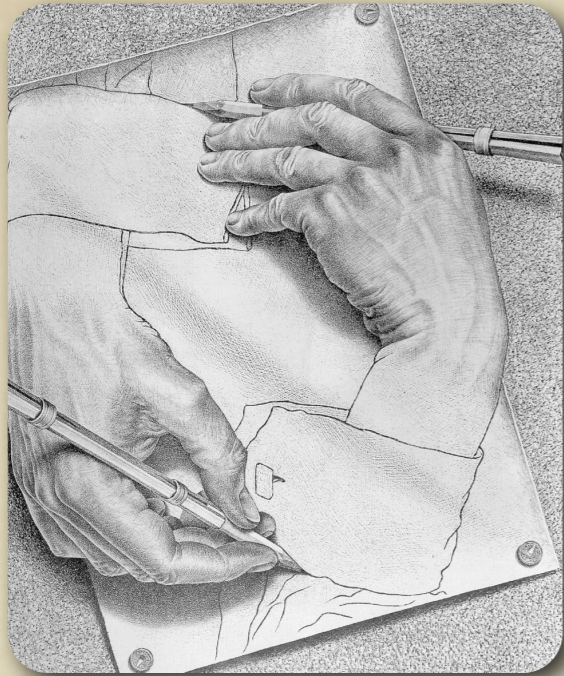




$$U = \begin{pmatrix} 1 & 0 & 0 \\ 0 & c_{23} & s_{23} \\ 0 & -s_{23} & c_{23} \end{pmatrix} \begin{pmatrix} c_{13} & 0 & s_{13}e^{\delta} \\ 0 & 1 & 0 \\ -s_{13}e^{\delta} & 0 & c_{13} \end{pmatrix} \begin{pmatrix} c_{12} & s_{12} & 0 \\ -s_{12} & c_{12} & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

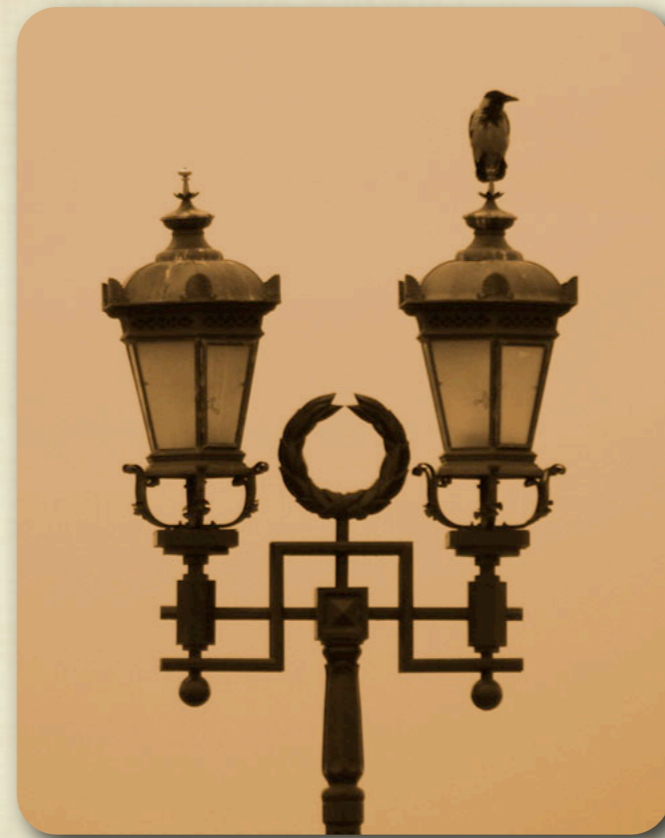




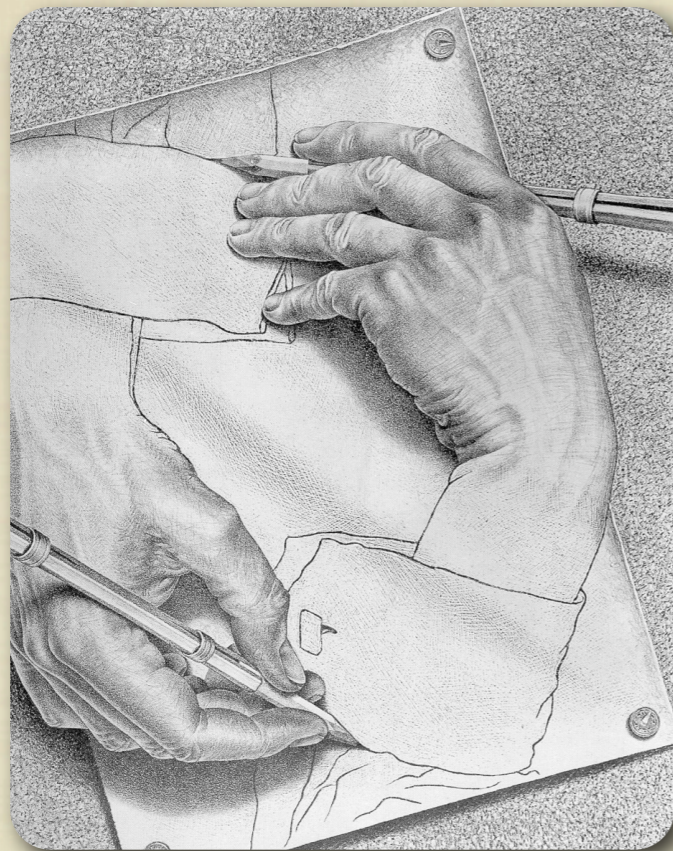


IS THIS IMPORTANT?

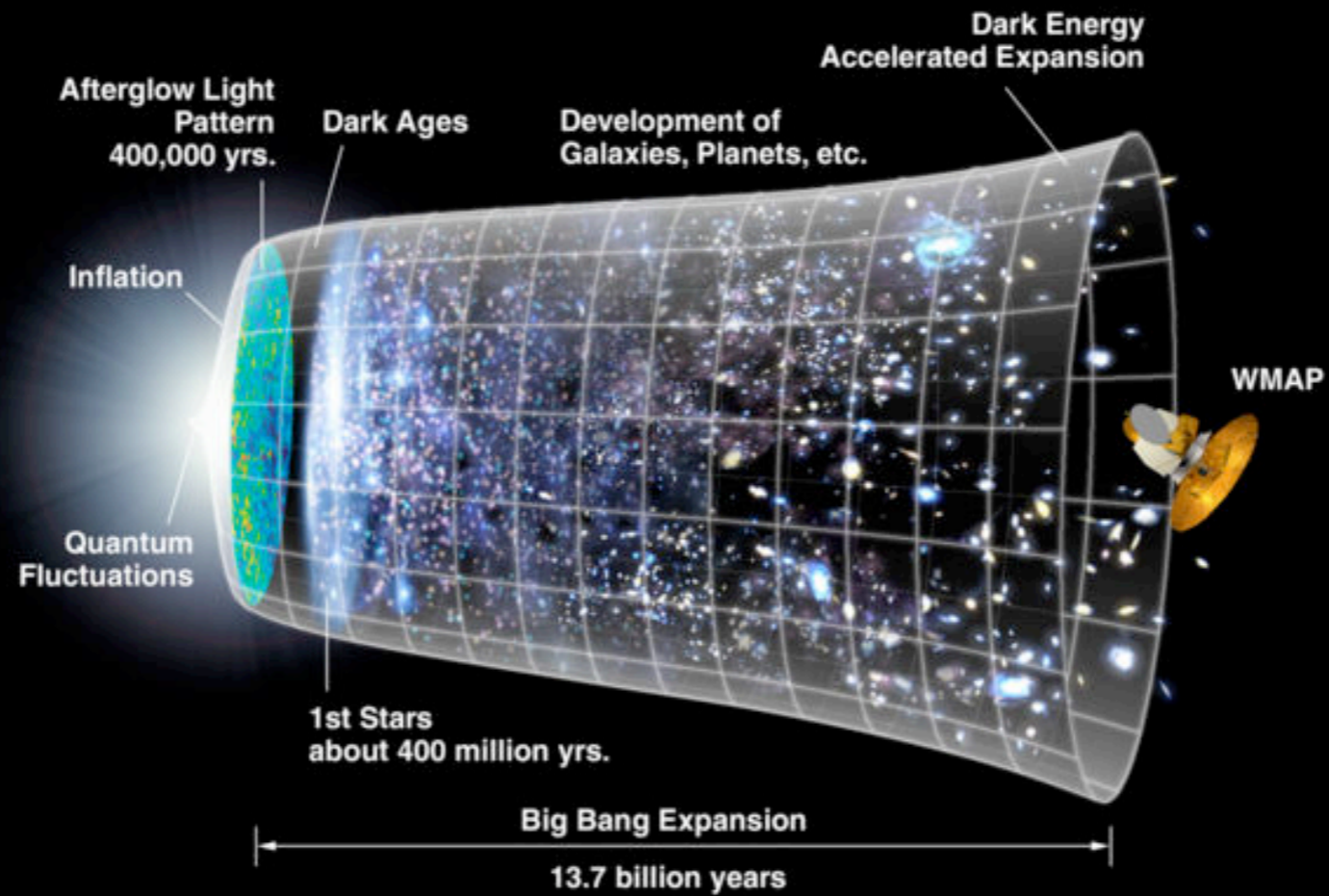
IS THIS IMPORTANT?



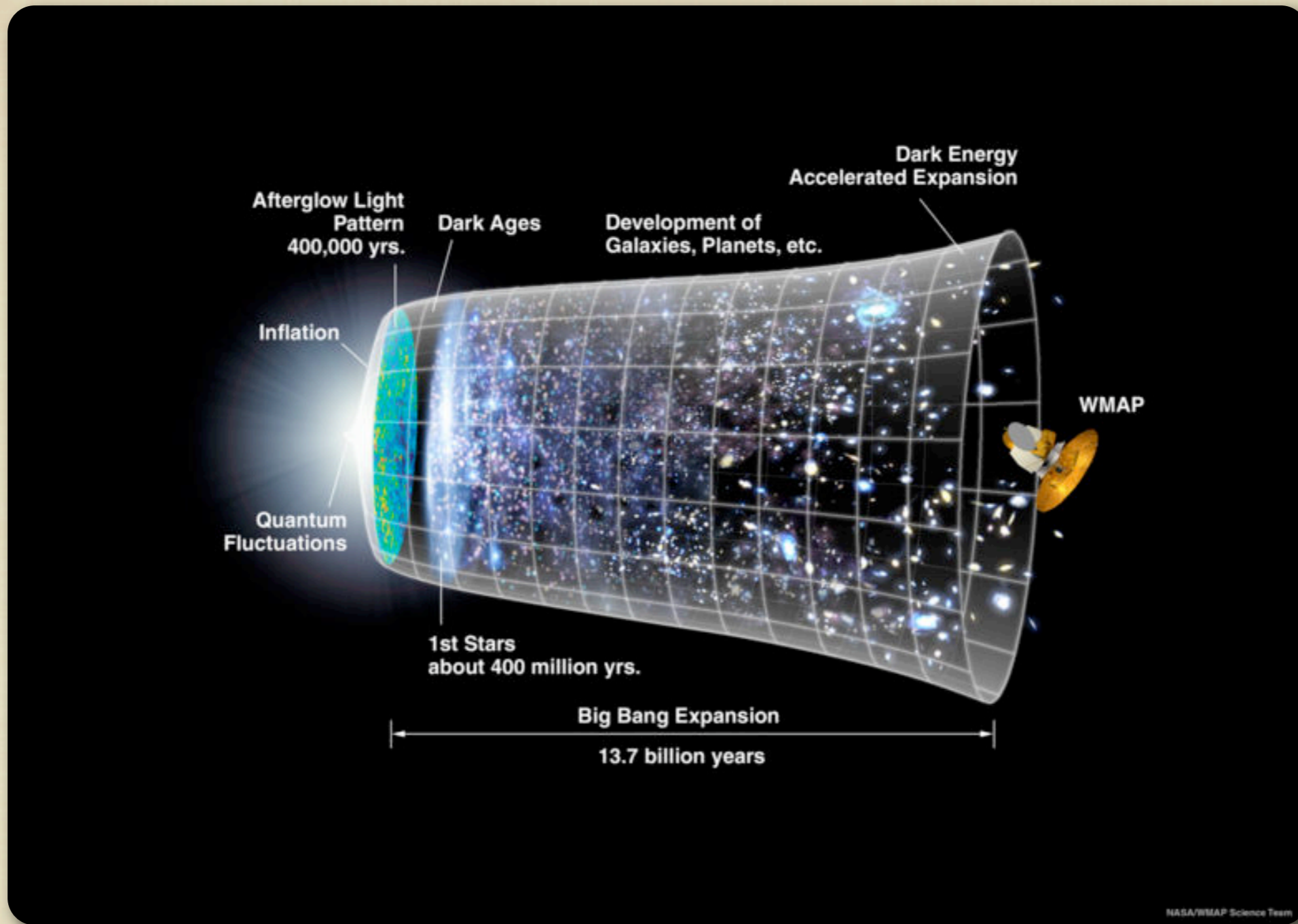
IS THIS IMPORTANT?



...WHY ARE WE HERE?



...WHY ARE WE HERE?



WHY THE UNIVERSE IS MADE OF MATTER?

MAYBE NEUTRINOS PLAY A CENTRAL ROLE?

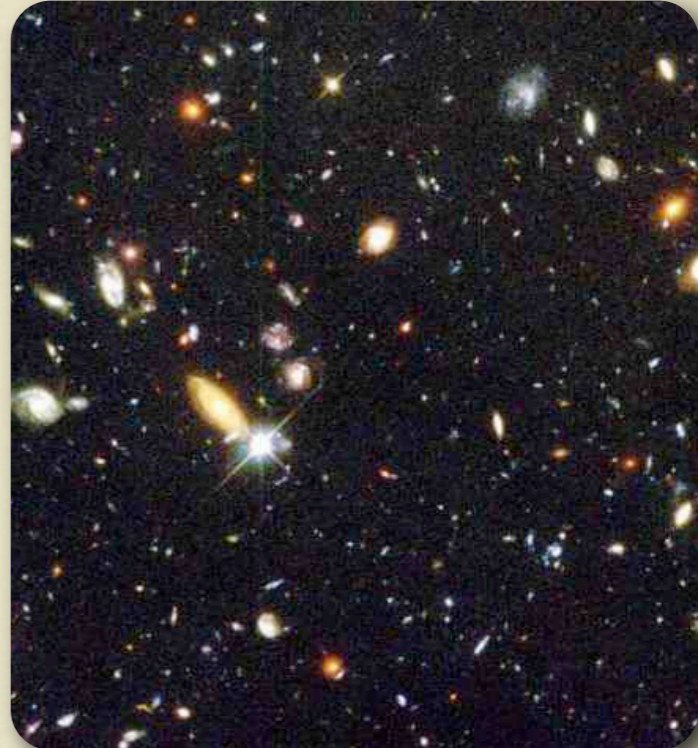
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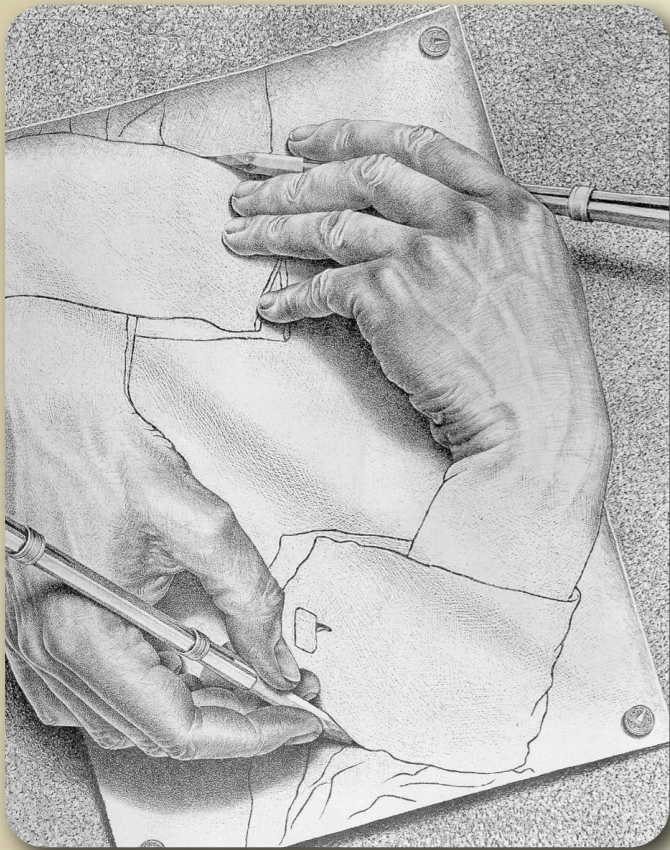
MAYBE NEUTRINOS PLAY A CENTRAL ROLE?

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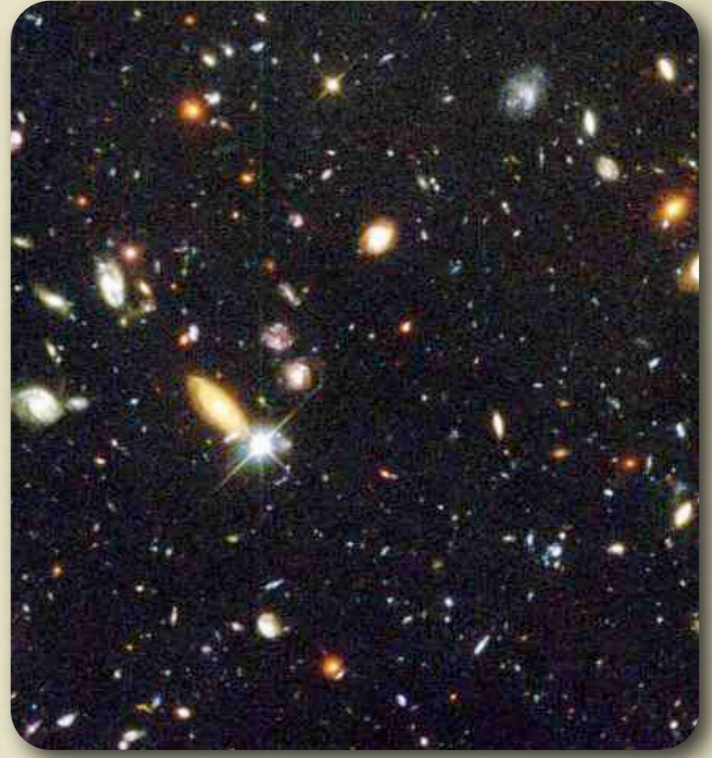


MAYBE NEUTRINOS PLAY A CENTRAL ROLE?

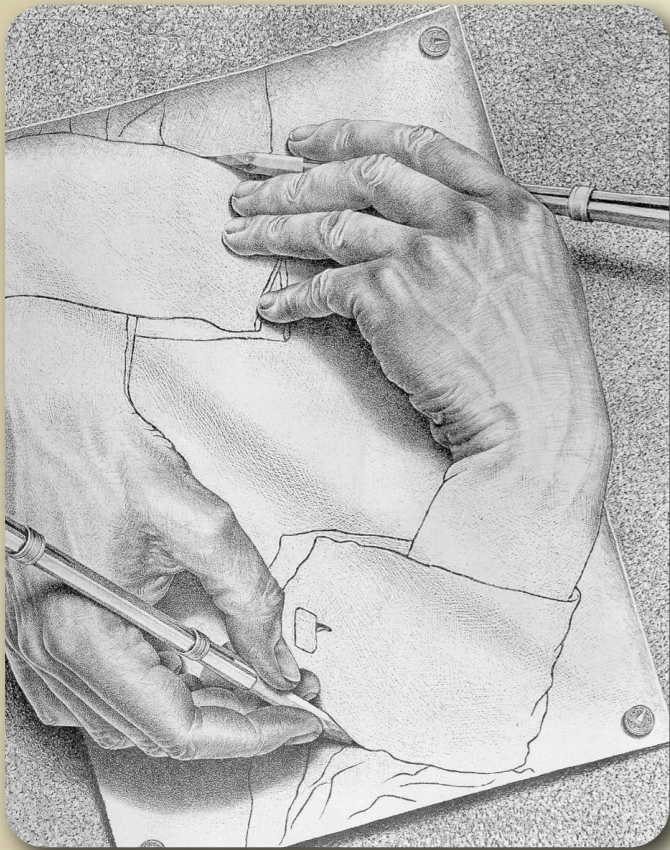


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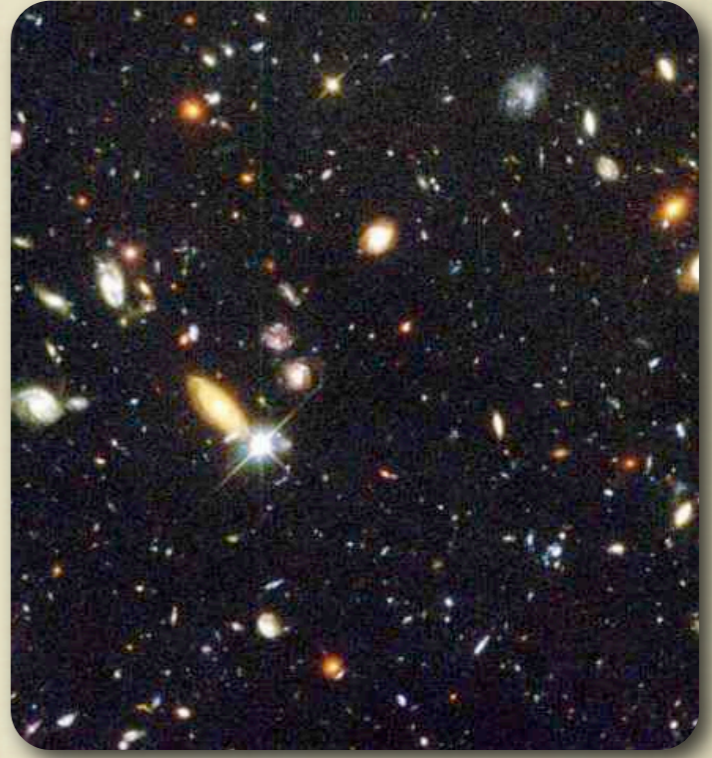
MAYBE NEUTRINOS PLAY A CENTRAL ROLE?



+



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...DEAR SIR ARTHUR...



CANADA



RUSSIA



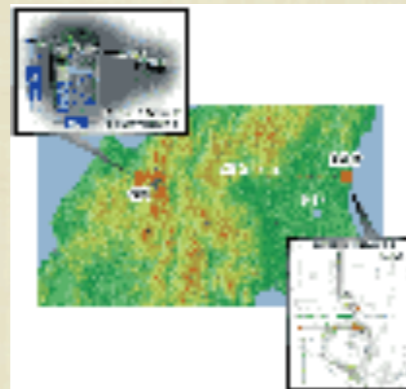
ITALY



FRANCE



USA



JAPAN



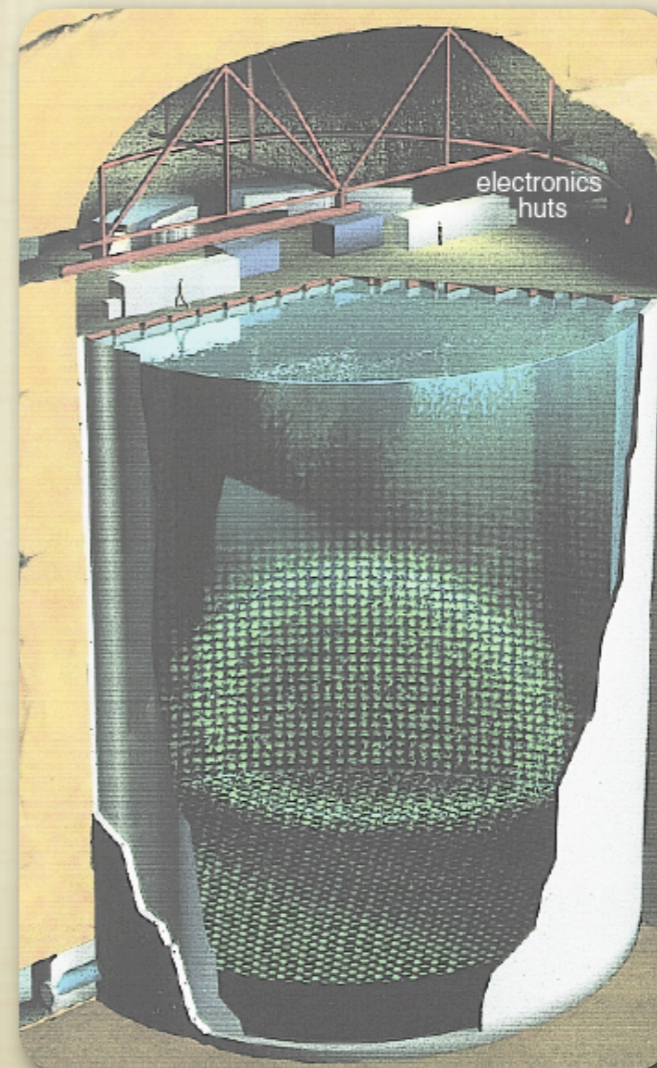
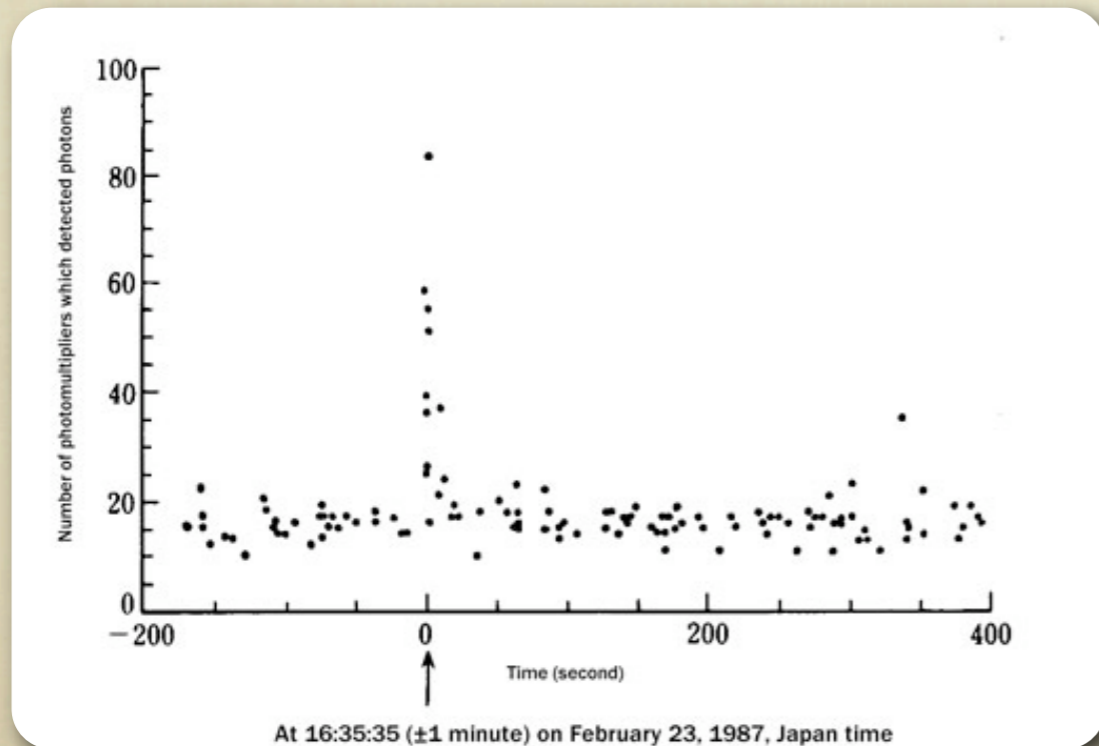
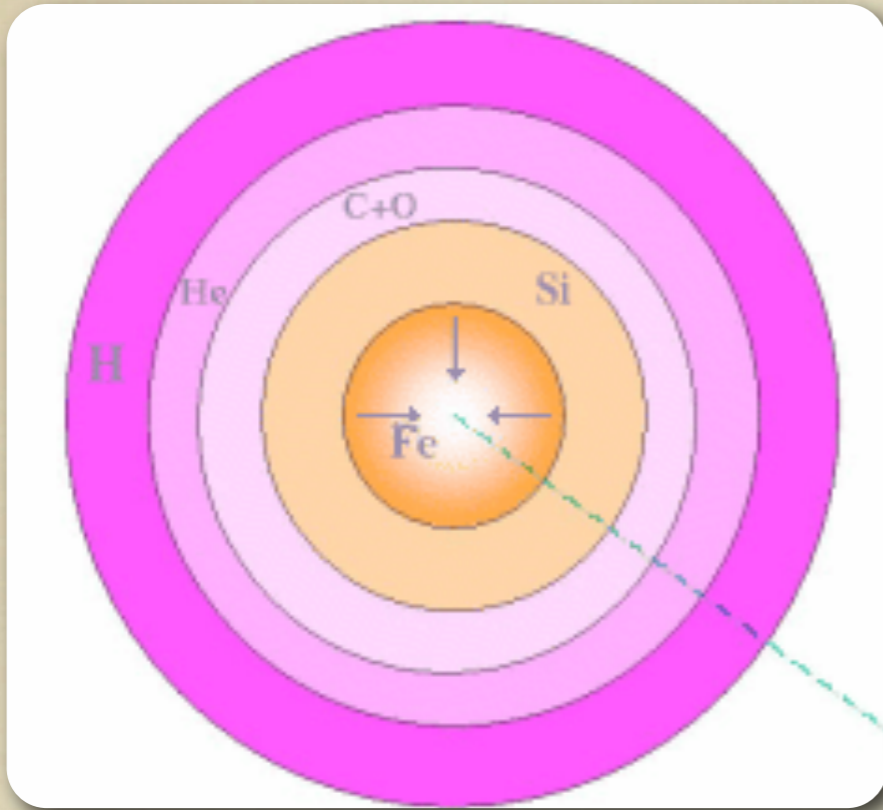
SPAIN



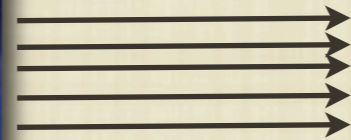
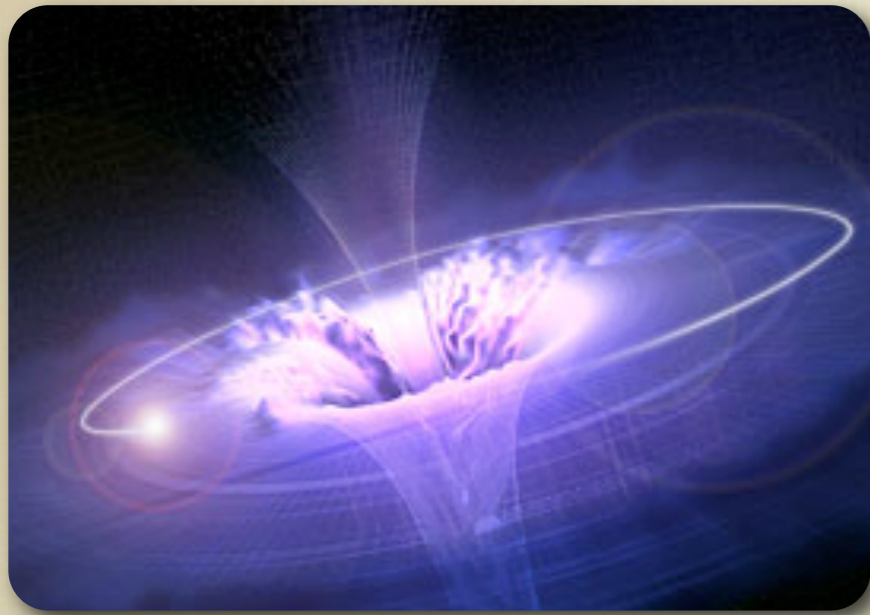
SOUTH POLE

JUST TO NAME A FEW!

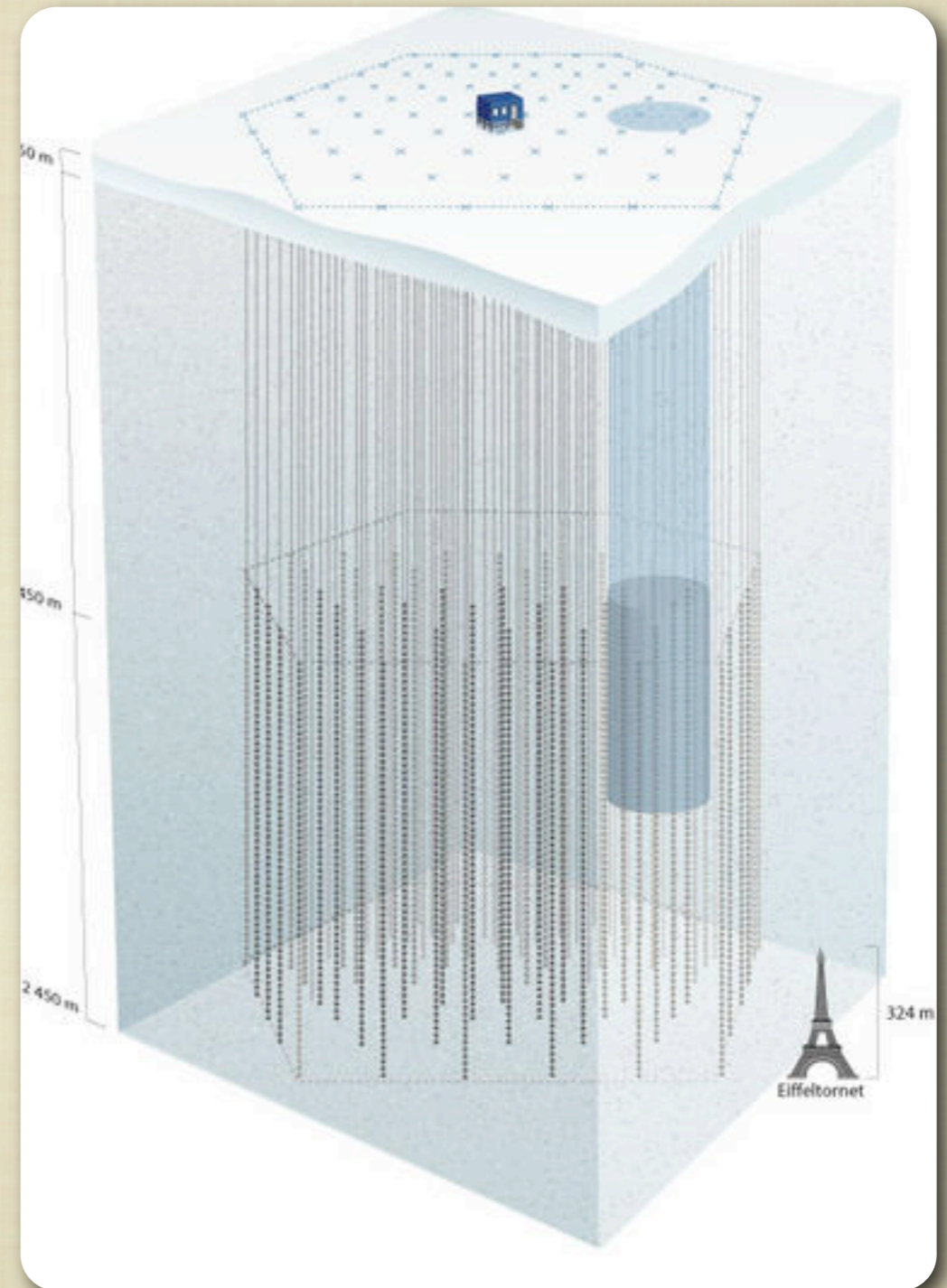
...NEUTRINOS FROM SUPERNOVAS



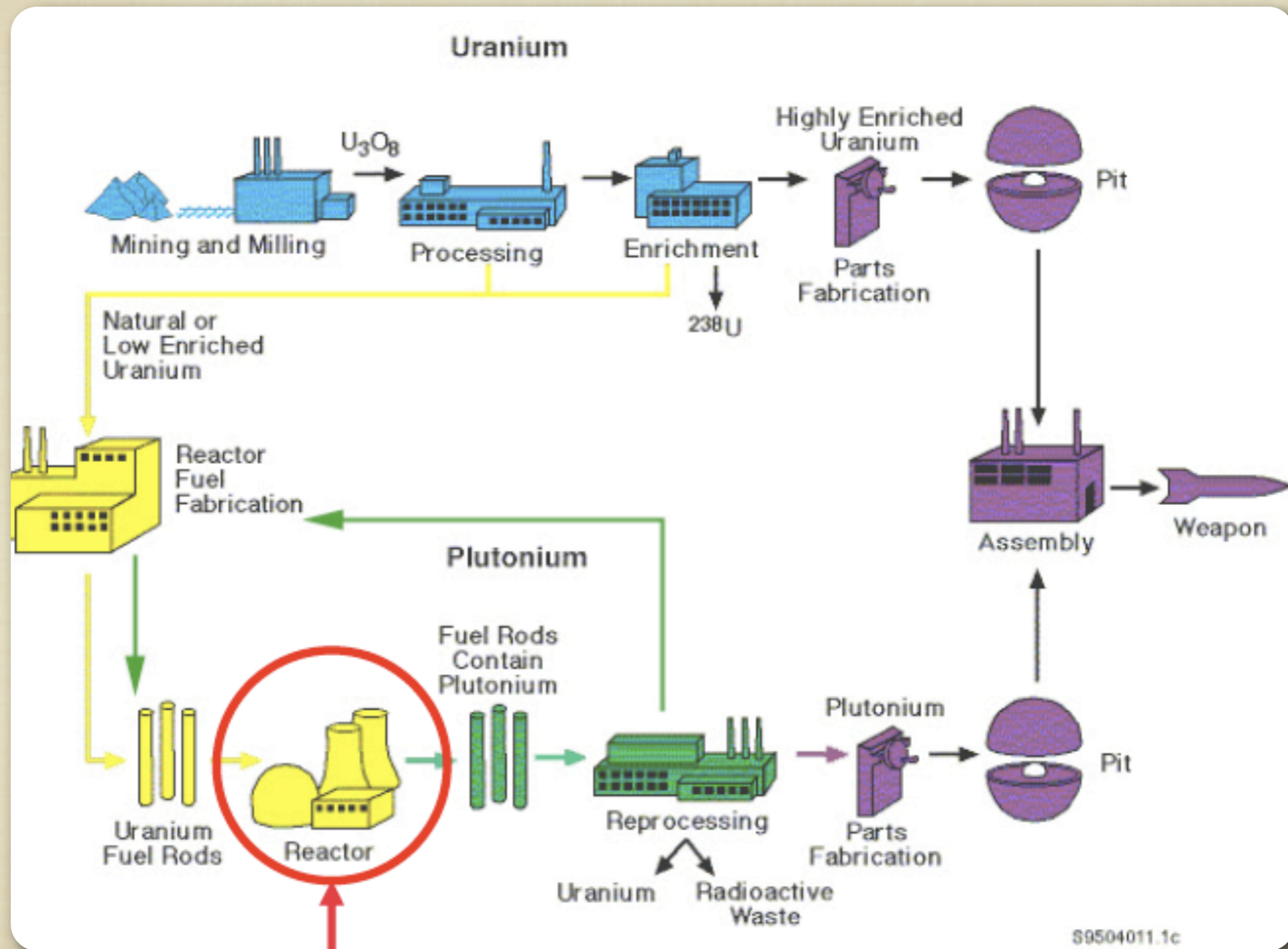
AND BEYOND...

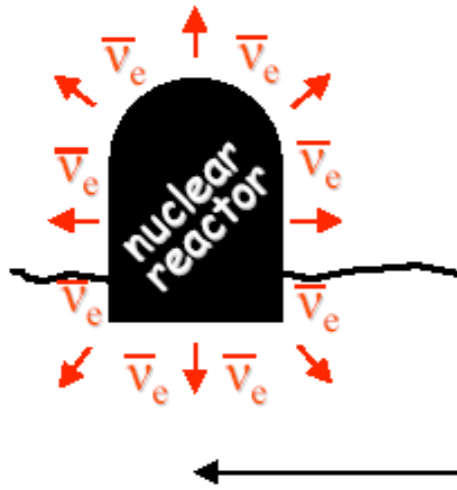


$$\bar{v}_e$$

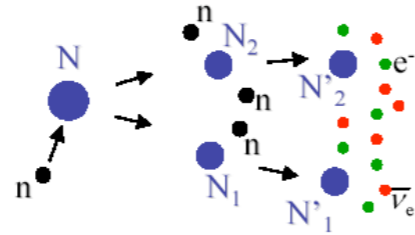


...NEUTRINOS & NON-PROLIFERATION

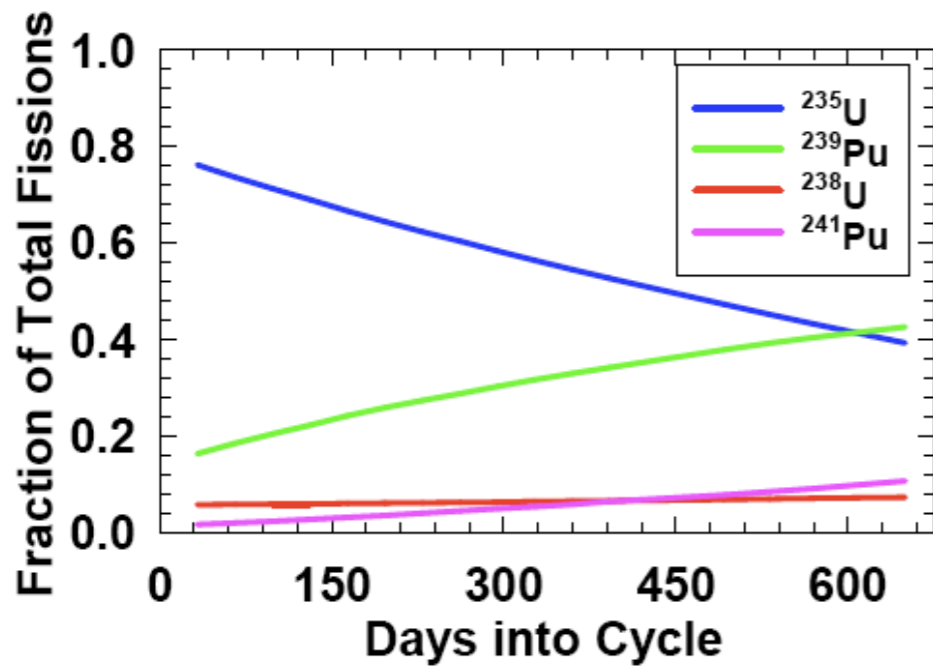
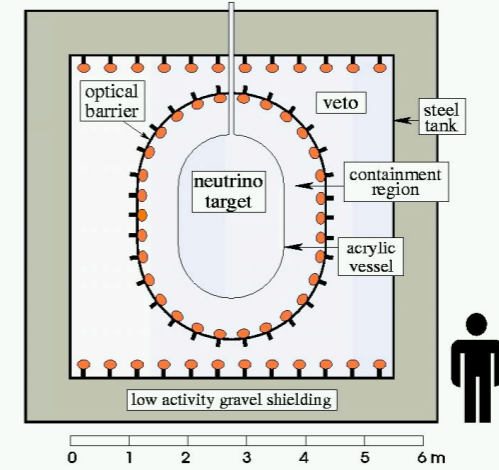




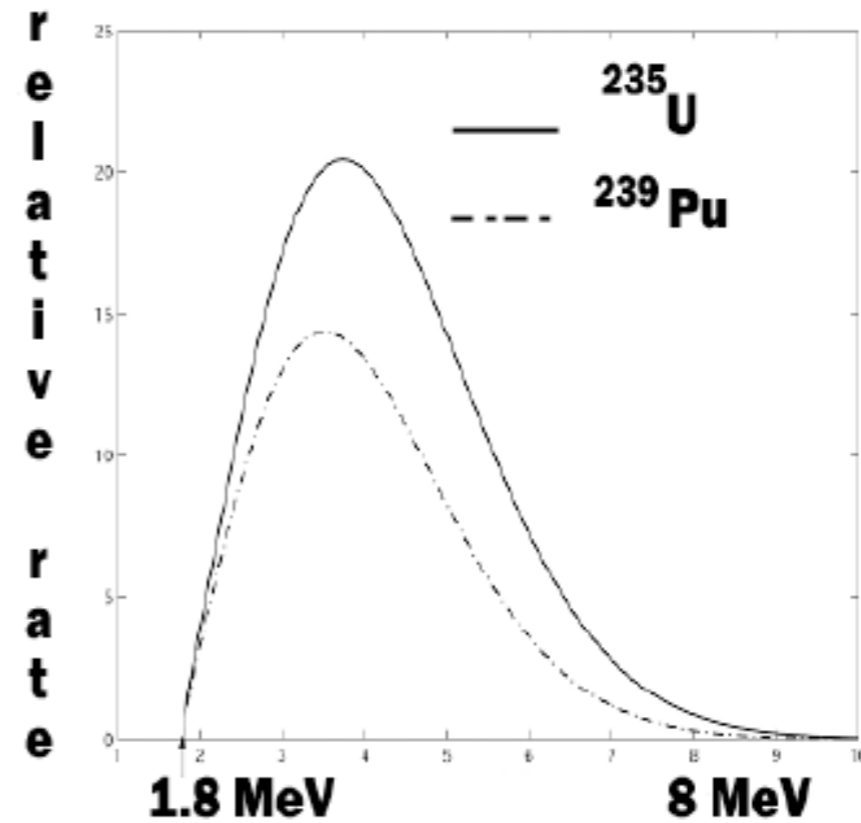
Nuclear reactors are very intense sources of $\bar{\nu}_e$ deriving from beta-decay of the neutron-rich fission fragments



Yield:
 $200 \text{ MeV} / \text{fission}$
 $6 \bar{\nu}_e / \text{fission}$



Relative Fission Rates Vary in Time



Rate of Antineutrinos/Fission Varies With Isotope

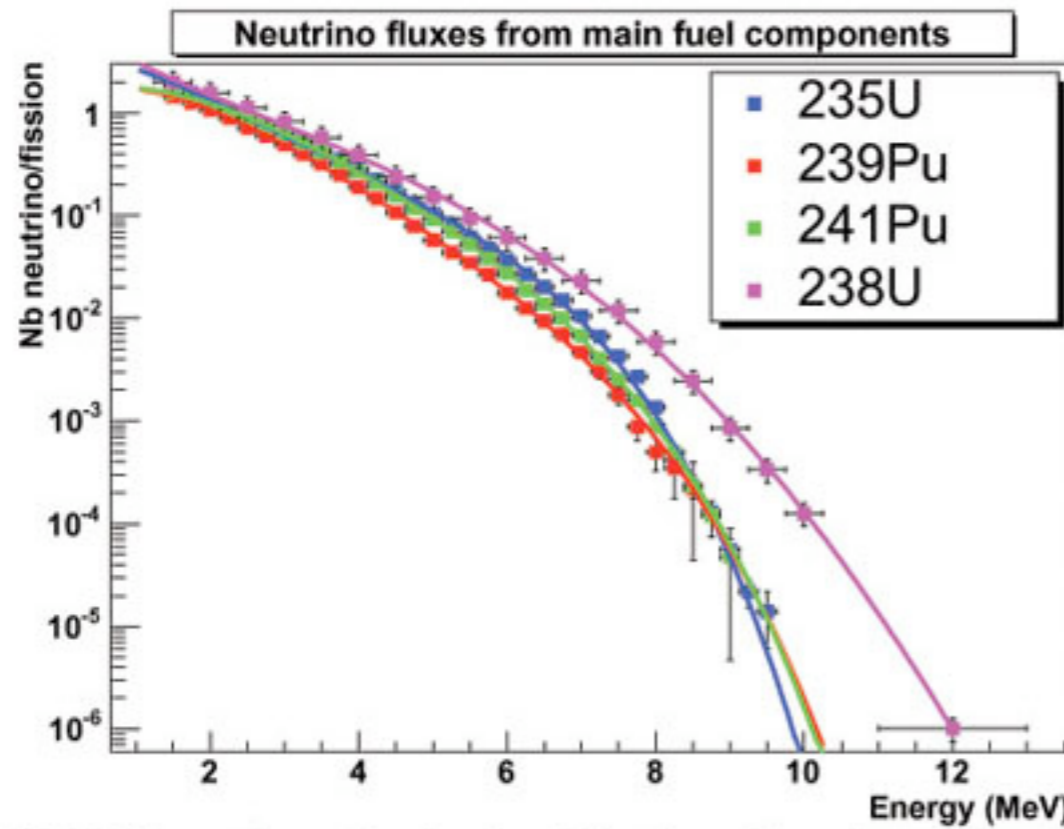


FIG. 7: Measured spectra of antineutrinos from the main components of the nuclear fuel. Taken from Ref. [20].

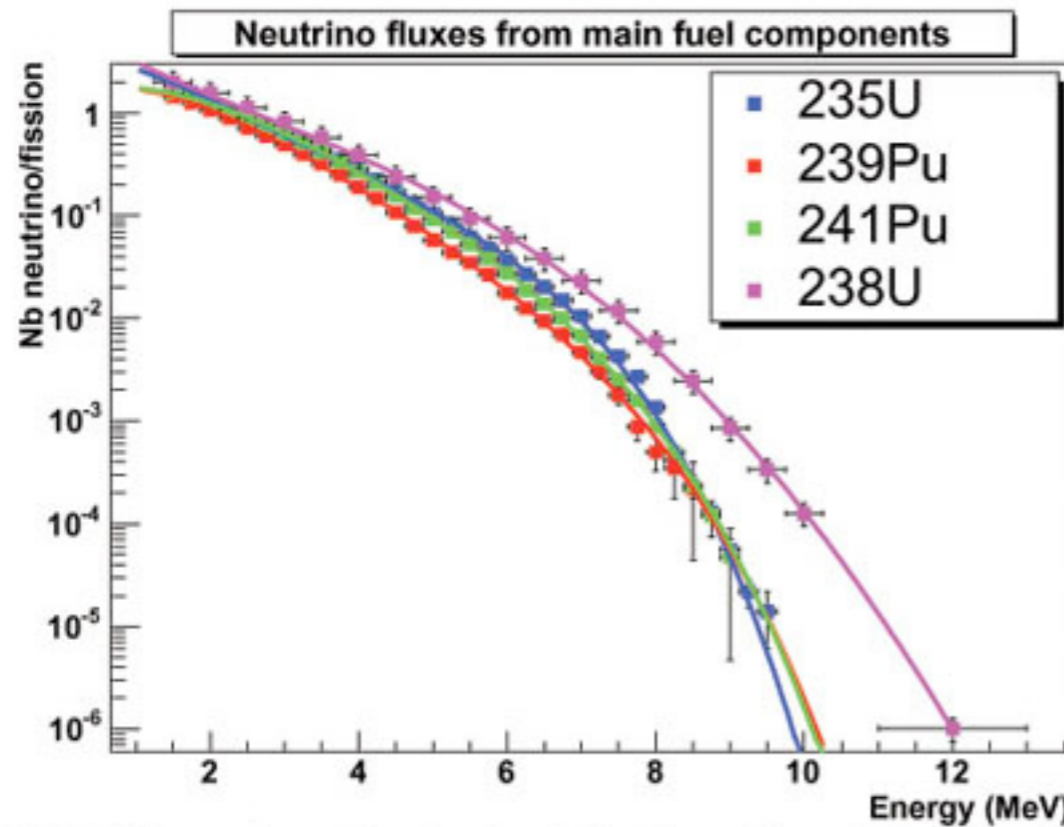
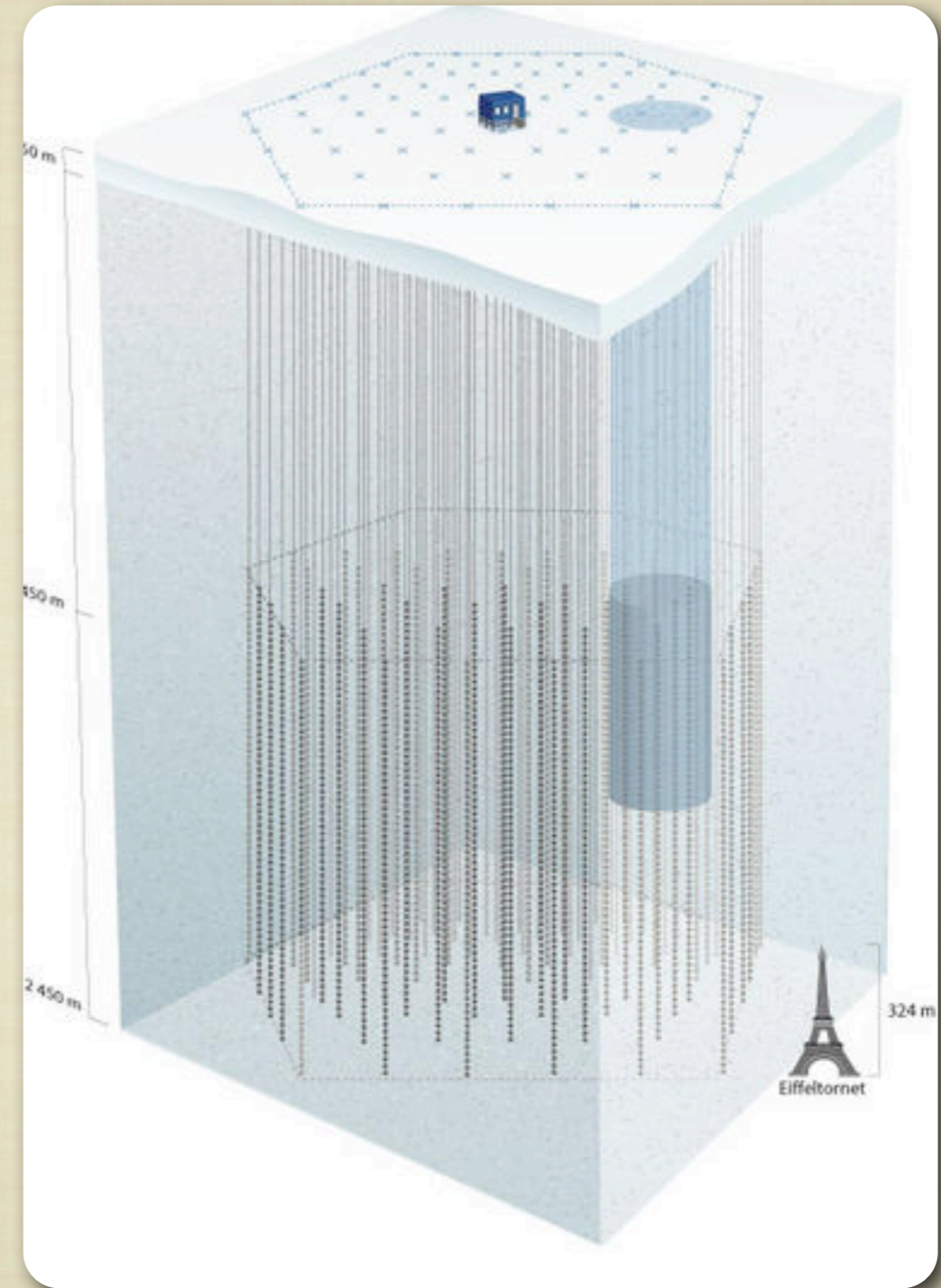
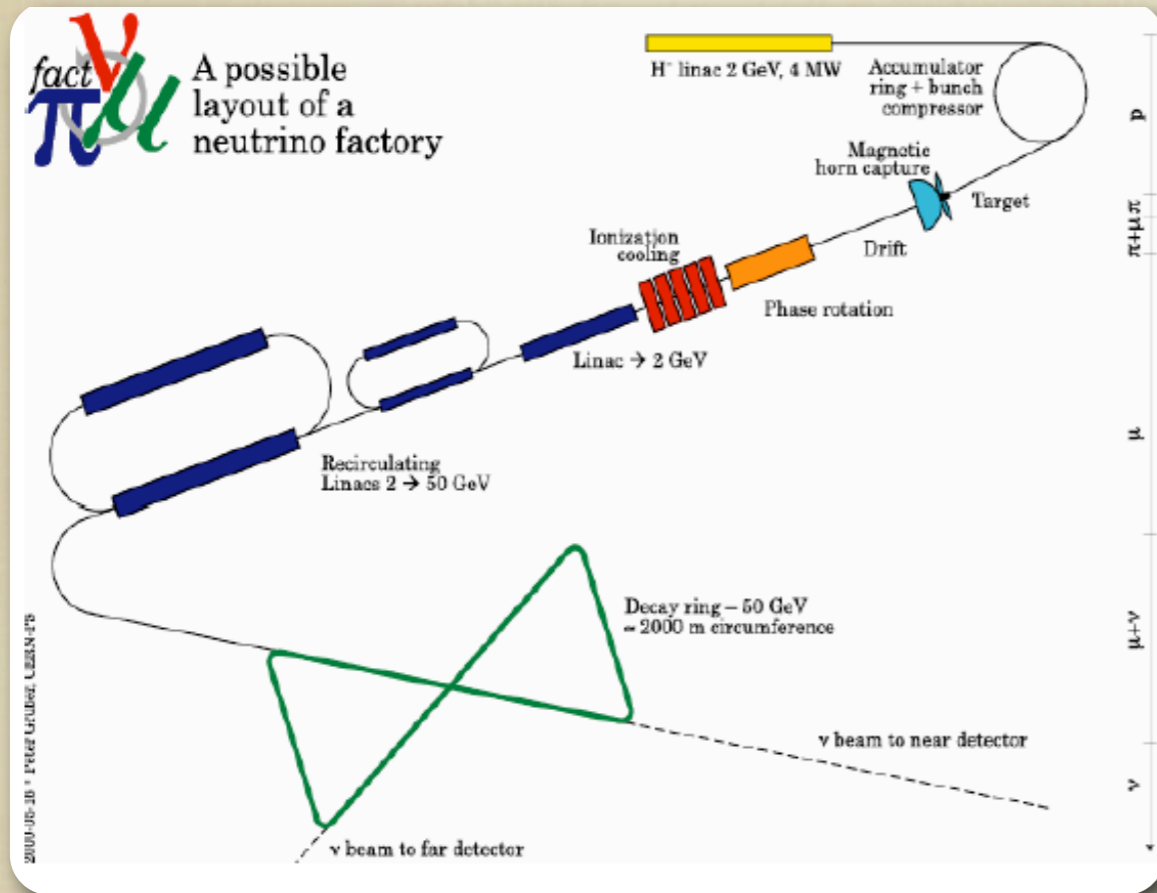


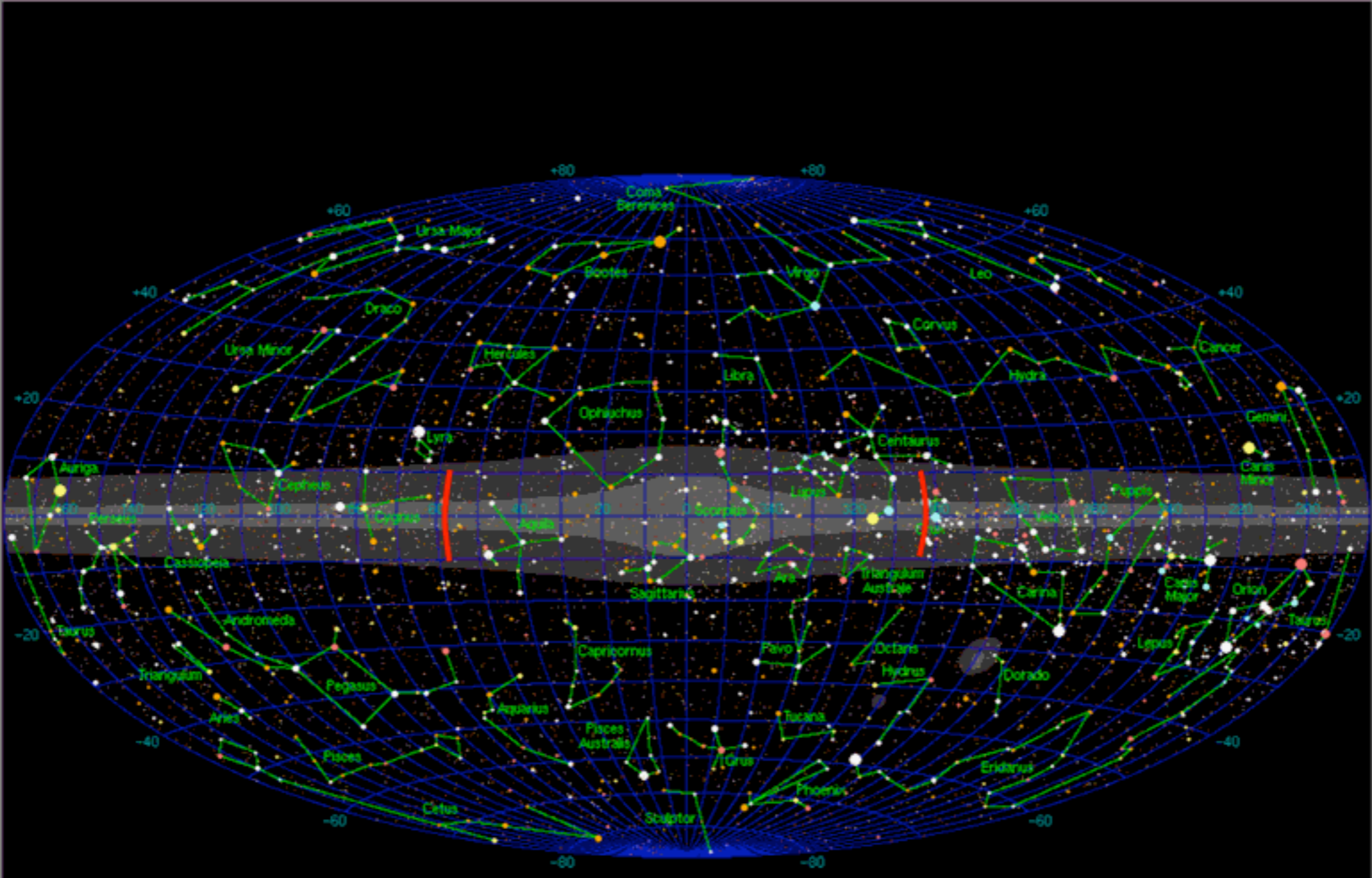
FIG. 7: Measured spectra of antineutrinos from the main components of the nuclear fuel. Taken from Ref. [20].



...MAYBE THE GALAXY IS EMITTING IN NEUTRINO FREQUENCY...?



...MAYBE NEUTRINOS ARE THE TICKET TO GALACTIC NETWORK?



All-Sky View Toward Milky Way Center with 1-Radian Markers (Red)









