Monday, March 23, 2026

Example: Neutrino production during the SN 1987A supernova.

SN 1987A is estimated to have unleashed about 10^{58} neutrinos over a few seconds (i.e. 2.5 seconds for this problem)

distance of SN 1987A = 168,000 light years

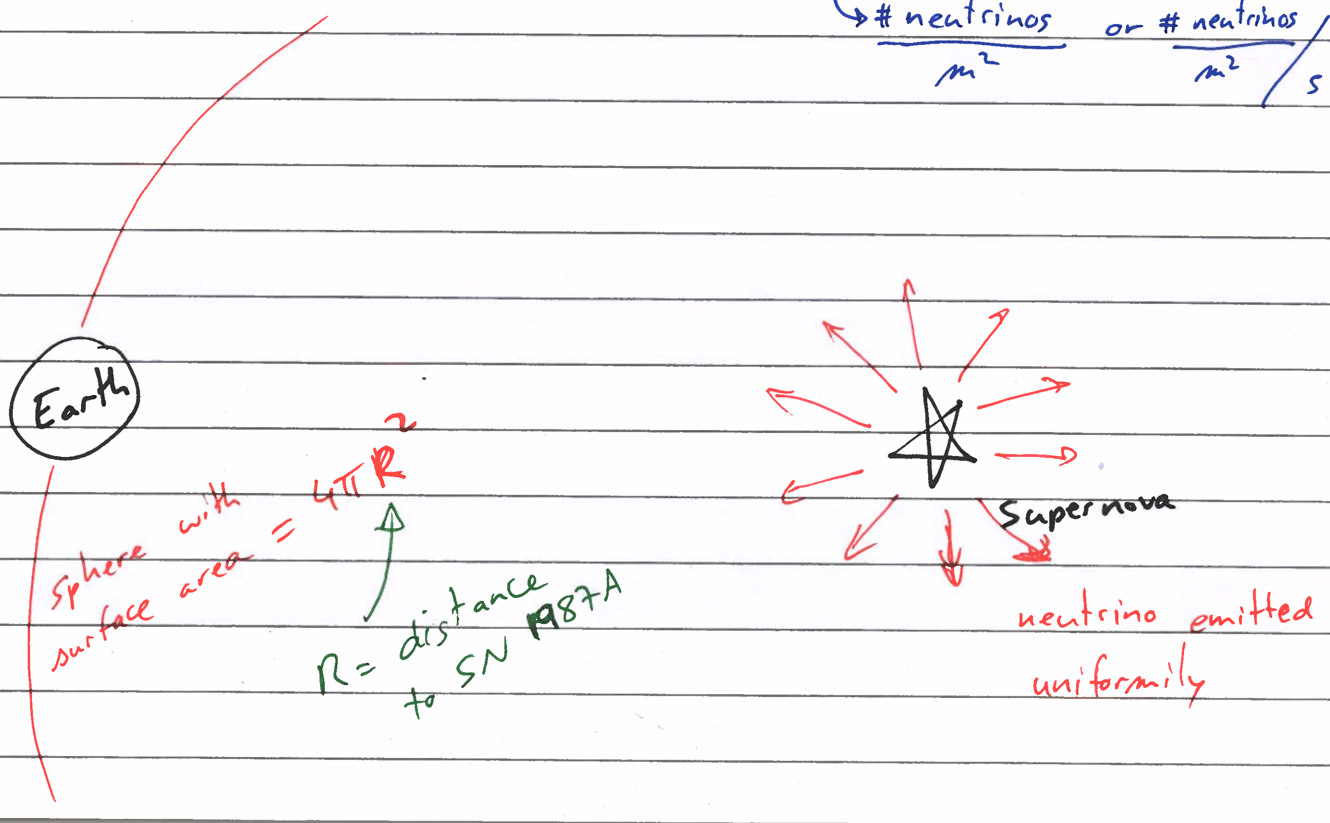
$= (1.68 \times 10^5)(9.46 \times 10^{15})$

$= 1.59 \times 10^{21}$ m

$1 \text{ ly} = 9.46 \times 10^{12}$ km
$= 9.46 \times 10^{15}$ m

Question: What was the neutrino flux on Earth from SN 1987A

flux → $\frac{\#\text{ neutrinos}}{m^2}$ or $\frac{\#\text{ neutrinos}}{m^2} / s$



$$\text{Area} = 4(3.1415926)(1.59\times10^{21}\ m)^2$$
$$= 3.174\times10^{43}\ m^2$$

$$\text{neutrino flux} = \frac{\#\text{ of neutrinos}}{\text{Area}} = \frac{10^{58}}{3.174\times10^{43}} = 3.15\times10^{14}$$

$$\simeq 3\times10^{14}\ \text{neutrinos}/m^2$$

$$\Rightarrow \boxed{\text{neutrino flux} = 3\times10^{14}\ \text{neutrinos}/m^2}$$

$$\text{flux per second} = \frac{\text{neutrino flux}}{\text{pulse duration}} = \frac{3\times10^{14}\ \text{neutrinos}/m^2}{2.5\ s}$$

$$= 1.26\times10^{14}\ \frac{\text{neutrinos}}{m^2\cdot s}$$

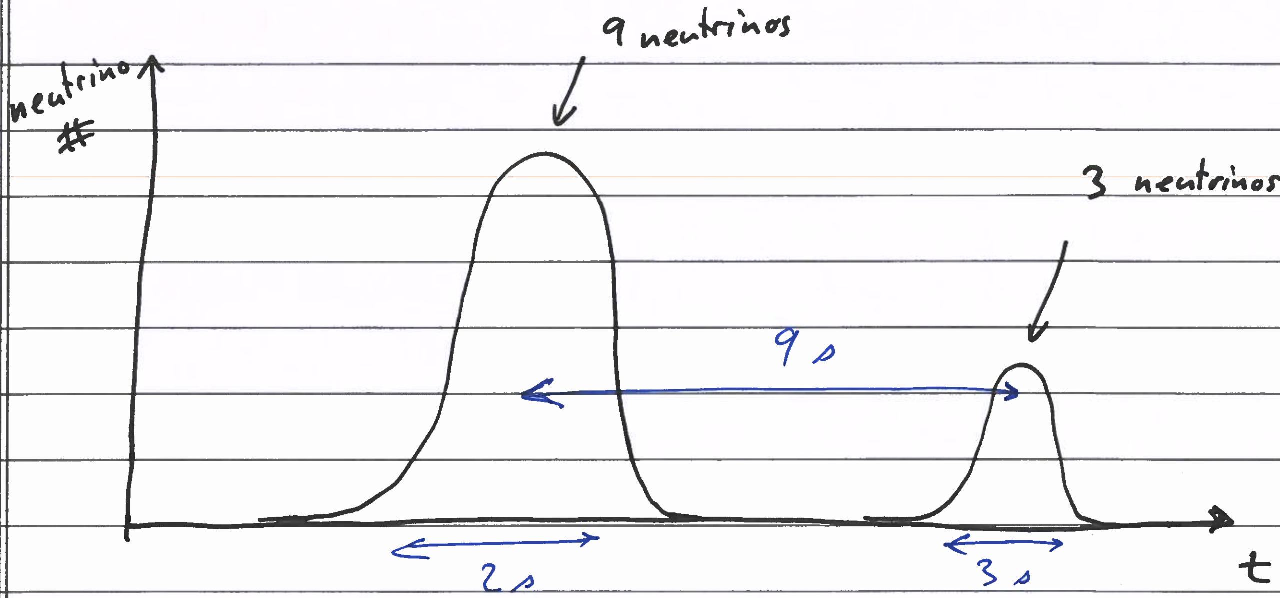
$$\Rightarrow \boxed{\text{neutrino flux per second} \simeq 10^{14}\ \frac{\text{neutrinos}}{m^2\cdot s}}$$

$10^{14} = 100$ trillion

note: neutrinos are in the 10-15 MeV range

Note: Solar neutrino flux per second $= 7\times10^{16}\ \frac{\text{neutrinos}}{m^2\cdot s}$

↳ most of the solar neutrinos are in the 100-400 keV range.



KamioKande - II neutrino signal for SN1987A