

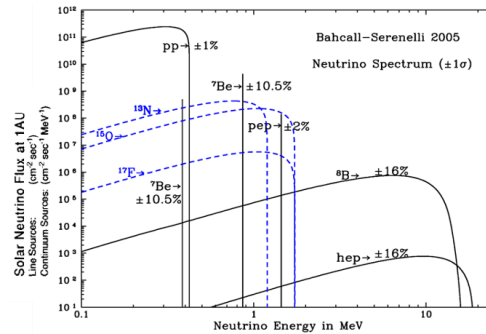
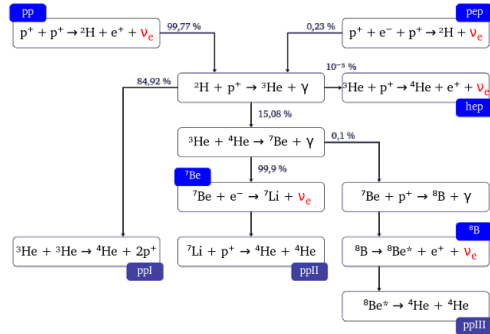
# Introduction to astroparticle physics

## Part 2, Exercises 5

May 23, 2025

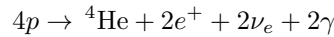
### 1 Maximum Energy of pp Solar Neutrinos

Compute the maximum energy of the pp solar neutrinos.



### 2 Solar neutrino flux at Earth

Neutrinos from the Sun come mostly from the reaction:



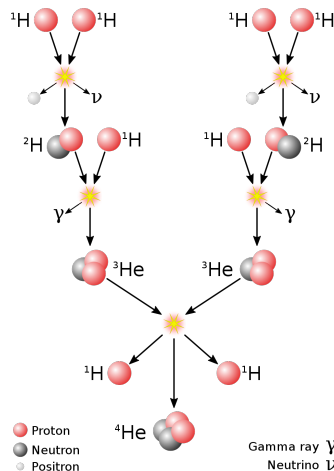
- What is the energy gain per reaction?
- How many solar neutrinos arrive at Earth per square meter per second?

Binding energies:

[http://barwinski.net/isotopes/query\\_select.php](http://barwinski.net/isotopes/query_select.php).

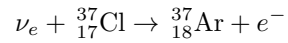
Nominal solar constant (the power of the Sun at Earth):

<https://pdg.lbl.gov/2023/reviews/rpp2023-rev-astrophysical-constants.pdf>



### 3 Threshold energy of the Homestake experiment

Homestake was the first solar-neutrino detection experiment. Located in the Homestake gold mine in South Dakota, at 1.5 km deep, it collected data from 1970 to 2002. It was a radiochemical solar-neutrino experiment, its detection reaction was:



Demonstrate that the threshold energy of the previous reaction is 0.82 MeV.

### 4 The Crab Pulsar

The Crab Pulsar emits gamma rays of  $E_\gamma = 100$  GeV with a power  $P = 3 \times 10^{27}$  W. Assuming that the collecting area of the Fermi experiment is  $A = 8000$  cm<sup>2</sup>, and the distance between Crab and Fermi is  $R = 3400$  light-years, how many photons of energy  $E_\gamma$  are recorded per year by Fermi if the photon emission is isotropic?