Übung am 06.05.2010 zur VL "Astroteilchenphysik und Kosmologie", Aufgaben A und B siehe unten!

Example 3.6
Suppose that four hypothetical narrow s-wave resonances occur at low energies in the ^{20}Ne(p,γ)^{21}Na reaction. The resonance energies are $E_r = 10$ keV, 30 keV, 50 keV, and 100 keV. The corresponding resonance strengths are $\omega\gamma = 7.24 \times 10^{-33}$ eV, 3.81×10^{-15} eV, 1.08×10^{-9} eV, and 3.27×10^{-4} eV. Each of these values has been obtained by assuming $\Gamma_p \ll \Gamma_\gamma$ and $C^2S = 1$. Which resonance do you expect to dominate the total reaction rates at $T = 0.02$ GK and 0.08 GK?

At $T = 0.02$ GK, the Gamow peak location (see Eqs. (3.74) and (3.78)) is $E_0 \pm \Delta/2 = 40 \pm 10$ keV. Only the resonances at $E_r = 30$ keV and 50 keV are located in the Gamow peak and, therefore, these will dominate the reaction rates. At $T = 0.08$ GK, we obtain $E_0 \pm \Delta/2 = 100 \pm 30$ keV. Only the resonance at $E_r = 100$ keV is located in the Gamow peak and thus will dominate the total reactions rates. See also Problem 3.5.

A **3.5** Consider the narrow resonances described in Example 3.6. Calculate the reaction rates numerically for $T = 0.02$ GK and $T = 0.08$ GK and show that the arguments based on the Gamow peak concept are valid.

B Calculate the rate for the reactions ^{14}N(p,γ) and ^{15}N(p,α) for the conditions in the center of the Sun (density $\varrho = 100$ g/cm^3, hydrogen mass fraction X_H=0.7, temperature 16 MK). Derive the differential equation for the creation and destruction of ^{15}N. Which isotopic ratio ^{15}N/^{14}N do you expect once equilibrium has been reached?

You may use the reaction rates from the NACRE website:
http://pntpm.ulb.ac.be/Nacre/nacre_d.htm

Webseite der Vorlesung:
http://www.fzd.de/pls/rois/Cms?pOid=30632&pNid=2041