

Bitte die Heftung nicht öffnen !

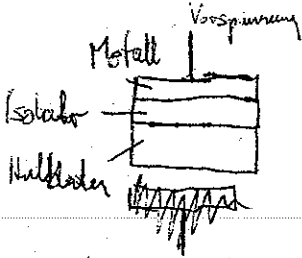
Bitte um kurze prägnante Antworten und achten Sie bitte etwas auf Schriftbild und Form !

Please do not open the stitching !

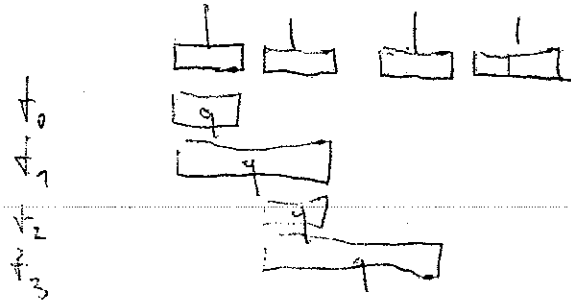
Please, short concise answers and pay attention a little bit on script and form !

1) Sketch the principles of

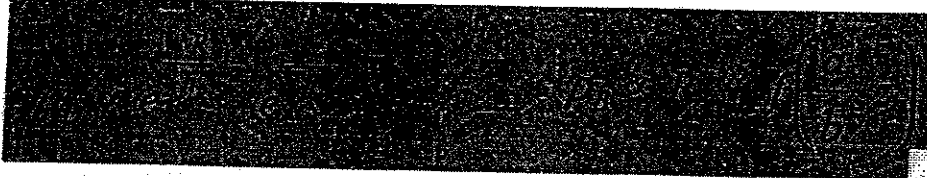
a) an individual CCD cell



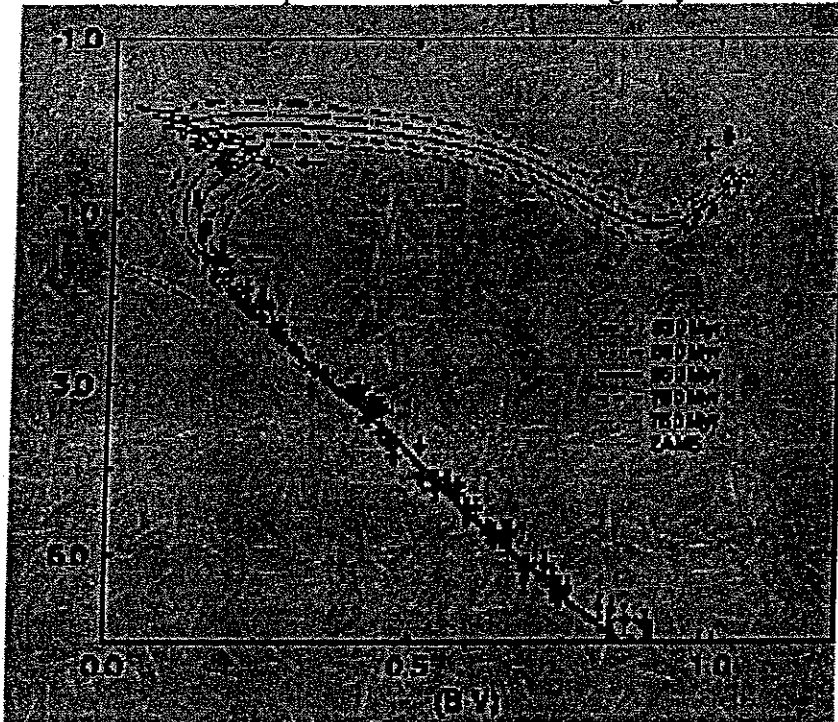
b) the readout of a CCD



2) Label what describes the disk and what the bulge & halo population and how do they dynamically stabilize



3) Which line marks the youngest and which one the oldest cluster and mark what we call the "turnoff" and which part of the tracks are changed by the chemical abundance?



4) What do the Eulerian equations describe (label it beside them)? What else is required to solve the whole system.

1)  $\frac{\partial \rho}{\partial t} + \nabla(\rho \mathbf{u}) = 0$

Kontinuitätsgl.

Erhaltung Masseerhalten

2)  $\frac{\partial(\rho \mathbf{u})}{\partial t} + \nabla(\rho \mathbf{u} \otimes \mathbf{u}) = -\nabla p + \rho \mathbf{k}$

Impulserhaltung

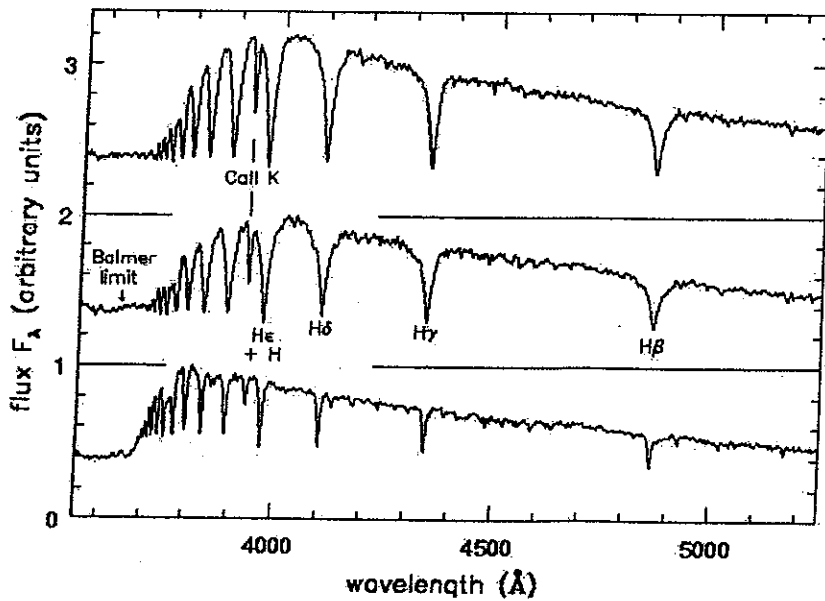
3)  $\frac{\partial(\rho \epsilon)}{\partial t} + \nabla(\rho \epsilon \mathbf{u}) = -p \nabla \mathbf{u}$

Energieerhaltung

Anfangs- und Randbedingungen festlegen

5) What does AMR mean and how does it work ? What is the difference between grid and mesh grid hydrodynamics on the one side and SPH on the other side ?

6) Below there are spectra of three stars with similar temperature. How do we determine the Luminosity class (or the surface gravity and thus the size respectively) ? Why do the lines changes that way ?



- 7) How are cosmic gamma rays detected at the Earth's surface ?
- 8) What is the ratio of dark matter to total matter in the universe ?
- 9) Write down the Weyl equations for free relativistic particles in the limit  $m=0$ .  
Which two physical properties follow from them ?
- 10) Describe differences between electro-weak and strong interactions. Which fundamental fermions are subject to these interactions ? What is the common principle ? What makes the weak interactions so weak ? Which symmetries are violated by which interaction ?

11) Which properties of the "charmonium" system of states  $\psi(3.1)$ ,  $\psi(3.7)$ , ... were considered unusual at the time of their discovery? What is the generally accepted interpretation of these states?

12) The strong coupling  $\alpha_s$  is predicted by QCD to vary with energy like  $\alpha_s^{-1} = 2 b_0 \ln(q/\Lambda)$ , where  $b_0 = 23 / (12\pi)$  is a constant. The value of  $\alpha_s$  has been measured to  $\alpha_s = 0.12$  at an energy  $q_2 = 100$  GeV. Compute its value at a much larger energy,  $q_1 = 1000$  GeV.  
Useful hint: Eliminate  $\Lambda$ .

