

3. Naloga: Fotometrija in HR diagram

Aperturna fotometrija je način merjenja svetlosti zvezd, kjer na posnetku izmerimo koločino signala znotraj nekega radija okoli slike zvezde. Izmerjen signal lahko potem pretvorimo v magnitudo, ki jo pripišemo dotični zvezdi. *Iraf* ima že pripravljene metode, ki iz seznama koordinat zvezd na sliki izračunajo magnitudo zvezd (ukaz `phot` v paketih `noao.digiphot.apphot`). Pripravljena je tudi procedura, ki zna poiskati zvezde na danem posnetku (`daofind` v istih paketih). Ta nam pride še posebej prav, če želimo poiskati več sto zvezd na posnetki, kot jih boste obravnavali v tej nalogi.

Iz izmerjenih magnitud v neki zvezdni kopici lahko naredimo HR diagram, kjer prikažemo magnitudo zvezd posnetih v enem filtru kot odvisnost od barve (razlike magnitud posnetih v dveh filtrih) zvezd. Ker vse zvezde kopice ležijo enako daleč od nas, niti ne rabimo prikazati absolutnih magnitud ali izsev, ampak so navidezne magnitude dovolj.

Iz oblike HR diagrama lahko sklepamo na starost kopice. Krivulja, na kateri bi se nahajale zvezde pri neki starosti se imenuje izohrona in jo lahko teoretično izračunamo. Če primerjamo različne izohrone z obliko našega HR diagrama in najdemo tiste, ki se najboljše prilegajo, smo določili starost kopice.

1. Iz arhivskih posnetkov Astronomskega observatorija na Golovcu izdelaj HR diagrama kopic M 67 in M 48. Posnetke lahko poiščeš na http://astro.ago.fmf.uni-lj.si/cgi-bin/poizvedba_register.py, kjer vidiš predogled posnetka in informacije o posnetku. *Fits* daoteke pa potem preneseš iz arhiva (<http://astro.ago.fmf.uni-lj.si/podatki/?C=N;O=A>).
2. Ugotovi starost kopic s pomočjo teoretično izračunanih izohron, ki jih najdeš na <http://stev.oapd.inaf.it/cgi-bin/cmd>. Za kopici lahko predpostaviš kovisnkost enako Soncu.

Nekaj problemov, na katere morate pomisliti pri reševanju naloge:

1. Kako izbrati parametre aperturne fotometrije, da bo magnituda čim bolj določena?
2. Na HR diagram želimo narisate zvezde kopice. Mnogo zvezd na sliki ne pripada kopici. Kako bi enostavno čim bolj povečali naš izkupiček zvezd kopice, brez da bi vključili preveč ostalih zvezd?
3. Če smo na naš HR diagram narisali navidezno magnitudo, teoretične izohrone pa podajajo absolutno magnitudo, kako bi izohrone in meritve spravili na enako skalo?

3. Homework: Photometry and HR diagrams

Aperture photometry is a method where the flux from each star is measured from within a small circular region around the image of a star. The measured signal can then be converted into the magnitude of a star. *Iraf* includes procedures that can measure the magnitudes for a list of stars, given a list of their coordinates on the image (command `phot` in packages `noao.digiphot`, `apphot`). There is also a procedure that finds stars on the image, which is especially useful for finding a large number of stars, like in this homework (`daofind` in the same packages).

From the magnitudes of stars in a cluster we can produce an HR diagram. It shows the magnitude of stars measured through one filter vs. the colour of the stars (difference of magnitudes measured through two filters). Because all stars lie at the same distance from us, we do not need to display absolute magnitudes or luminosities instead of apparent magnitudes.

From the HR diagram we can measure the age of the cluster. An isochrone is a curve describing where on the HR diagram should the stars of the same age be. It can be calculated theoretically. If we compare different isochrones with the shape of the HR diagram, we can find ones that fit the HR diagram best and derive the age of the cluster.

1. Create the HR diagrams of clusters M 67 and M48 from the images in the archive of the Astronomical observatory at Golovec. Images can be found here: http://astro.ago.fmf.uni-lj.si/cgi-bin/poizvedba_register.py, where you can see a preview and some information. You can then download the images from the archive (<http://astro.ago.fmf.uni-lj.si/podatki/?C=N;O=A>) in a *fits* format.
2. From the obtained HR diagrams measure the ages. Use isochrones obtained from <http://stev.oapd.inaf.it/cgi-bin/cmd>. You can assume Solar metallicities for both clusters.

A few problems to think about while solving this homework:

1. How do you choose the parameters of aperture photometry for the magnitudes to be as precise as possible.
2. On the HR diagram you want to plot the stars from the cluster. On the images there are many stars that do not belong into a cluster. How would you simply and effectively select the cluster stars?
3. If you plot the apparent magnitude onto the HR diagram, and get an absolute magnitude from the theoretical isochrones, how do you put both on the same scale?