4-й семестр, lesson6.
ROOT and simple functions

- **Several useful commands with vi editor**
- **Movement in buffer, " :10 " means move to 10th line**
- **Go to Insert mode : command I (insert) or R (replace)**
- **Return from Insert mode – command " ^["**
- **To add new text after current line "o" , before "O", at the end of line "a"**
- **Save result end exit – edit from input mode, then command   ZZ**
- **Exit without save – command   :q!**
- **Movement in buffer: use arrows or letters: j – down , k – up, h – left, l - right**
- **Delete 3 lines – 3dd; deleted lines are taken into buffer which can be used with commands : P – insert above current line; or p –insert after current line**
- **Open other file – command " :e! file2", if a buffer was filled in work with file1, it can be used now in work with file2**
- **The "substitute" command: Replace "text1" to "other" in all lines -> :1,$s?text1?other? Carriage return**
- **:u   it cancels the last command**
- **:↑ just calls the previous command**

Resonances in ($\pi^+ \pi^- \pi^{0)}$ system

- Exercises:
- 1) set link for input Ntuple:
- ln –s /nfs/lfi.mipt.su/data/student/2020/20200406/ntbeam_cher_r17_1_v15.root ntbeam_cher_r17_1_v15.root
- 2) copy file
- scp -p /nfs/lfi.mipt.su/data/student/2020/20200406/example_5_edited.C .
- Look for this file and run it in root :
- .X example_5_edited.C ;
- histogram h_002 is created and written to output file ntuple.root
- Try to fit the distribution in h_002 by a Gauss function in mass range (0.65, 0.90) GeV with example file from /nfs/lfi.mipt.su/data/student/2020/20200406/example_6_edited.C
- needed edition: please set the starting values for 3 parameters in the Gauss

Exercises cont.

- Please compare the fitted curve with histogram. You can set the OptFit in the Stat box, value 111
- 3) In order to improve agreement between data and fit result, let's include a Background term (linear function). An example available in
- scp –p /nfs/lfi.mipt.su/data/student/2020/20200406/example_7_edited.C
- .
- Again, needed a starting point for 3+2 parameters (which might be chosen very approximately)
- Compare difference between example_6 and example_7 :
- Ddiff example_7_edited.C example_7_edited.C

- Run the fit and look for result. Sttill the χ^2 is bad, but the agreement between the data and the fit result is significantly better.

Simple functions in ROOT script

- Let's consider decay $\eta \rightarrow \pi^+\pi^-\pi^0$ with known 4-vectors for π-mesons (px1, py1,pz1,e1),(px2,py2,pz2),(px3,py3,pz3,e3), respectively, and 4-momentum vector of η-meson (pxsum,pysum,pzsum,esum). All components are measured in the laboratory frame.
- Function loren4 can be used for transformation of 4-vector from laboratory frame to the η rest frame.

Library function loren4 for Lorentz transformation

- void loren4(double* dir, double* p4in, double* p4out) {
- double done = 1.0;
- double pcm2 = dir[0]*dir[0] + dir[1]*dir[1] + dir[2]*dir[2];
- double tmp = dir[3]*dir[3] - pcm2;
- double tmp2 = TMath::Sqrt(tmp);
- double onmcm = done/tmp2;
- double onmcm = done/TMath::Sqrt(dir[3]*dir[3] - pcm2);
- double epbeta = p4in[0]*dir[0] + p4in[1]*dir[1] + p4in[2]*dir[2];
- double prod   = epbeta*(dir[3]*onmcm -done)/pcm2 - p4in[3]*onmcm;
- p4out[3] = onmcm*(p4in[3]*dir[3] - epbeta);
- for(int i=0; i<3; i++) {
- p4out[i] = p4in[i] + dir[i]*prod;
- }
- }
- Here dir 4-vector define new center of mass system, p4in is initial 4-vector,
- t4out – 4-vector after transformation

Example 3

- double   dir[4];
- dir[0] =pxsum;
- dir[1]=pysum;
- dir[2]=pzsum;
- dir[3]=esum;
- double dp1lab[4];
- double dp1scm[4];
- dp1lab[0]=px1;
- dp1lab[1]=py2;
- dp1lab[2]=pz1;
- dp1lab[3]=e1;
- loren4(dpsum, dp1lab, dp1scm);

Exercise 4:

- Make software link to input NTuple
- ln –s /nfs/lfi.mipt.su/data/student/2020/20200406/ntbeam_cher_r17_1_v15.root ntbeam_cher_r17_1_v15.root
- Copy file /nfs/lfi.mipt.su/data/student/2020/20200406/my_test_8.C .
- Input file reading, loop over events, calculation of fm3=m(3π) system and call of “loren4” is available.
- Edit my_test_8.C, to do:
- select events in η peak (0.543<fm3 && fm3<0.553) [mass m(η) = 548 Mev)
- Calculate total moments p1scmtot, p2scmtot, p3scmtot in the (3π) rest frame.
- Check that sums of px, py and pz components are close to zero (histograms h_006, h_007, h_008).
- Since spin of all particles in this case = 0 and orbital moment in this decay = 0 also, the density of points on Dalitz plot should be uniform.

Exercise 4-5 cont.

- Select events in the ω peak, i.e. (0.763<fm3 && fm3<0.803) and produce previous distributions with this selection (mass m(ω) = 783 MeV)
- ω-meson has spin-parity $J^P = 1^-$ and one can see concentration of events in the center of Dalitz plot
- Table of particle properties is available at http://pdg.lbl.gov/
- The matrix element for $\omega \rightarrow \pi^+\pi^-\pi^0$ decay is proportional to squared of pseudo-vector which can be constructed from the decay momenta in the ω-meson rest frame
- detailed description of amplitudes for meson decays into 3 pions can be found in Zemach "Three-Pion Decays of Unstable Particles“ Phys.Rev. 133 (1964) V.5B B1210
- A description of Dalitz plot properties can be found of book by Bykling and Kajantie, “Kinematics of elementary particles” in Russian, http://ikfia.ysn.ru/images/doc/Atomic_and_Nuclear_Physics/BycklingKajantie1975ru.pdf

Exercise 4-5

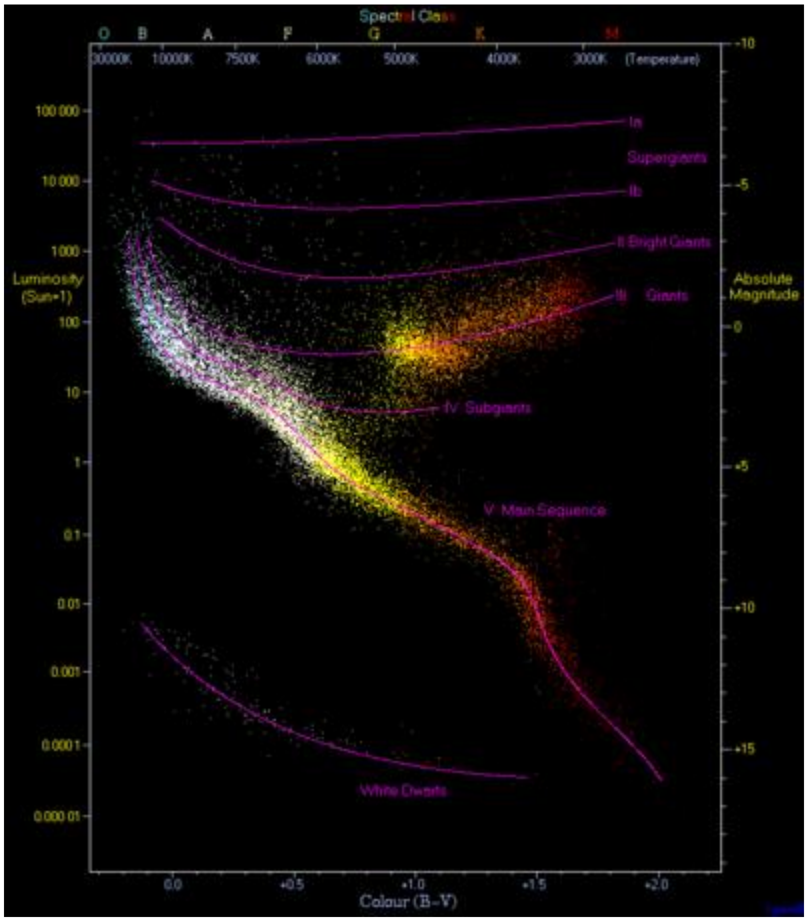
- Let’s prepare distributions on the normal to the decay plane for η and ω decays into $\pi^+\pi^-\pi^0$.
- We need a function which gives the vector products of two vectors:
- void cross(double* v1, double* v2, double* v3)
- {
- v3[0] = v1[1]*v2[2] - v1[2]*v2[1];
- v3[1] = v1[2]*v2[0] - v1[0]*v2[2];
- v3[2] = v1[0]*v2[1] - v1[1]*v2[0]; }
- The maximum length of vector v3 is reached at the center of the Dalitz plot. Neglecting the difference between masses of charged and neutral π, this $A_{max} = \sqrt{3}/2 \cdot (M^2_{tot} - m^2_{\pi})$.
- The calculated amplitude (i.e. the normal vector) is divided by A_{max} and taken in quadrature.
- See ROOT tutorials

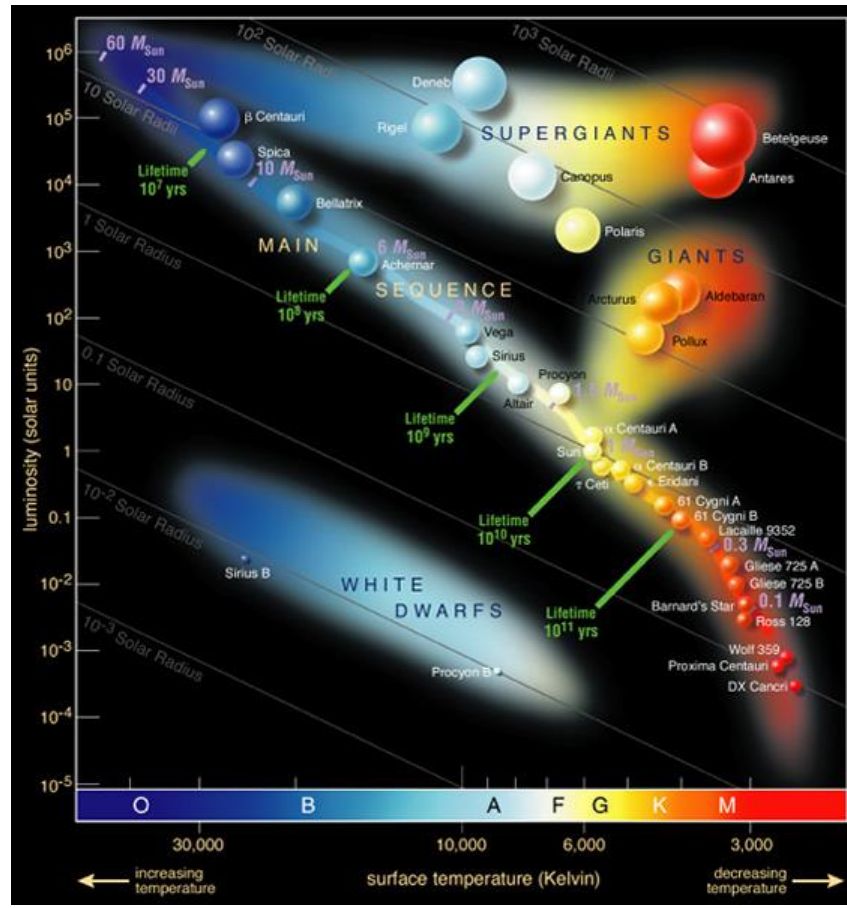
Exercise 6

- Copy /nfs/lfi.mipt.su/user/n/nikola/2020/20200406/my_test_9.C
- .
- Root –l my_test_9.C
- {
- TFile *_file0 = TFile::Open("ntuple_test_9.root");
- TF1 *myfit2 = new TF1("myfit2","gaus(0)+pol1(0)",0.0, 0.999);
- h_003->Fit("myfit2","eR+");
- }
- The Vector product of pi+ and pi- momenta produced
- The vector product distribution rises linearly (because omega spin-parity 1-)

Hertzsprung–Russell diagram

https://en.wikipedia.org/wiki/Hertzsprung%E2%80%93Russell_diagram





Hertzsprung–Russell diagram

- The Hertzsprung–Russell diagram, abbreviated H–R diagram, HR diagram or HRD, is a scatter plot of stars showing the relationship between the stars' absolute magnitudes or luminosities versus their stellar classifications or effective temperatures. More simply, it plots each star on a graph measuring the star's brightness against its temperature (color). It does not map any locations of stars.

- The diagram was created circa 1910 by Ejnar Hertzsprung and Henry Norris Russell and represents a major step towards an understanding of stellar evolution or "the way in which stars undergo sequences of dynamic and radical changes over time".