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function [  ] = Stellar_Collapse_1(  )
%Written by Elmer G. Wiens December 2018
%Stellar Collapse
%Eddington-Finkelstein Coordinates
M = 1; M2 = 2;
rv = 4.5;
up = 22; low = 7.5;
steps = 100;
figure(1)
hold on
vr = linspace(0, rv, steps);
vones = ones(1,steps);
tvones = [10.86, 11.37, 12.21, 15.42, 15.91, 17.03, 21] ;
for k = 1:length(tvones)
   plot(vr, tvones(k) * vones, 'b','LineWidth',2)
end
axis([0 rv low up])
line([0 rv], [0 0], 'Color','black','LineWidth',2)
line([0 0], [low up], 'Color','black','LineWidth',2)
line([M2 M2], [low up], 'Color','red','LineWidth',2)
line([0, rv], [up, up], 'Color','black','LineWidth',1)
line([rv, rv], [low, up], 'Color','black','LineWidth',1)
xlabel('r/M', 'FontSize',17)
ylabel('v', 'FontSize',17)
title({'Eddington-Finkelstein Coordinates','Null Geodesics: blue; Radial Geodesics: red'}, 'FontSize',15)
c = 10;
ct = [4,  0,  -4, - 8, -12, -16, -20];
rtu = 2.01;
r2 = linspace(rtu, rv, steps);
for j = 1:length(r2)
    rs2(j) = r2(j) + M2 * log(r2(j) / M2 - 1)  + c;
end
for i =1:length(ct)
   plot(r2, 2*rs2 + ct(i), 'b','LineWidth',2)
end
%return
c = 13.5;
stu = .01;
r1 = linspace(0, M2 - stu, steps);
for j = 1:length(r1)
   rs1(j) = r1(j) + M2 * log(abs( r1(j) / M2  - 1)) + c;
end
for i =1:length(ct)
   plot(r1, 2*rs1 + ct(i), 'b', 'LineWidth',2)
end

r = [.5, 1.5, 2.5,  3.0000,    3.5000, 4];
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for i = 1:length(r)
   line([r(i) r(i)], [low up], 'Color','red','LineWidth',1)
end
line([M2 M2], [low up], 'Color','red','LineWidth',2)
%taustar = 5.2704;
taustar = 8.83;
tau = linspace(0, taustar, steps*3);

for j = 1:length(r)
   tstar = - M2 * ( (-2/3) * (r(j)/M2)^(3/2) - 2 * (r(j)/M2)^(1/2) +
                                        log(abs(( (r(j)/M2)^(1/2) + 1) / ((r(j)/M2)^(1/2) - 1 ))));
   for i = 1:length(tau)
      rtau(i) = (3/2)^(2/3) * M2^(1/3)* (taustar - tau(i))^(2/3);
      ttau(i) = tstar + M2 * ( (-2/3) * (rtau(i)/M2)^(3/2) - 2 * (rtau(i)/M2)^(1/2) +
                                        log(abs(( (rtau(i)/M2)^(1/2) + 1) / ((rtau(i)/M2)^(1/2) - 1 ))));
   end
  for i = 1:length(rtau)
     rstau(i) = rtau(i) + M2 * log(abs( rtau(i) / M2  - 1)) + c;
     vtau(i) = ttau(i) +rstau(i);
   end
   plot(rtau, vtau, 'r', 'LineWidth', 3)
end

text(2.42, 13.6, 'r = 2.5M', 'FontSize',19)
plot(2.5, 13.23, 'k*', 'LineWidth', 3)
text(0.42, 12.8, 'r = 0.5M', 'FontSize',19)
plot(0.5, 12.51, 'k*', 'LineWidth', 3)
text(3.42, 16.9, 'r = 3.5M', 'FontSize',19)
plot(3.5, 16.42, 'k*', 'LineWidth', 3)

set(gca,'FontSize',19)

return
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