

Get the RMS values

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galaxies = ["NGC3198",
"NGC2841",
"NGC2955",
"NGC2403",
"NGC4389",
"NGC6015",
"NGC7793",
"NGC6946",
"NGC4013",
"NGC3521",
"NGC7331",
"UGC11914",
"UGC02487",
"UGC02953",
"UGC09133",
"UGC05253",
"UGC06787",
"UGC03205",
"UGC06786",
"UGC03580",
"UGC02916",
"UGC08699"];
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```
%% Looping through all galaxies
O_RMS_Newton = zeros(size(galaxies));
O_RMS_MOND = zeros(size(galaxies));
O_RMS_EG = zeros(size(galaxies));
RMS_Newton = zeros(size(galaxies));
RMS_MOND = zeros(size(galaxies));
RMS_EG = zeros(size(galaxies));
O_MAD_Newton = zeros(size(galaxies));
O_MAD_MOND = zeros(size(galaxies));
O_MAD_EG = zeros(size(galaxies));
MAD_Newton = zeros(size(galaxies));
MAD_MOND = zeros(size(galaxies));
MAD_EG = zeros(size(galaxies));
V_MOND = [];
V_tot = [];
totGalaxyMass = zeros(length(galaxies),6);
for (gal = 1:length(galaxies))
    load	append(galaxies(gal),"103_200b.mat"));

Rden = 1000*profile(:,1);
StarDen = profile(:,2);
integrand = 2 * pi * Rden .* StarDen;
totMassS = trapz(Rden, integrand);
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StarDen = profile(:,11);
integrand = 2 * pi * Rden .* StarDen;
totMassS_2 = trapz(Rden, integrand);

GasDen = profile(:,3);
integrand = 2 * pi * Rden .* GasDen;
totMassG = trapz(Rden, integrand);

Rden = 1000*r_model;
integrand = 2 * pi * Rden .* NSigma_S;
totEstMASS_S = trapz(Rden, integrand);

integrand = 2 * pi * Rden .* NSigma_H;
totEstMASS_G = trapz(Rden, integrand);

integrand = 2 * pi * Rden .* Sigma_obs;
totObsNewton = trapz(Rden, integrand);

TotMass = [totMassS,totMassS_2,totMassG,totEstMASS_S,totEstMASS_G,totObsNewton];

totGalaxyMass(gal,:) = TotMass;
fig = figure(gal);
fig.Position(3:4) = [1600,500];

[OV_tot,OV_MOND]=Vel_Newton_MOND(r_model,MStars,Mgas);
V_MOND(isnan(V_MOND)) = OV_MOND(isnan(V_MOND));
V_tot(isnan(V_tot)) = OV_tot(isnan(V_tot));
O_RMS_MOND(gal) = sqrt(mean((OV_MOND - V_model).^2));
O_RMS_Newton(gal) = sqrt(mean((OV_tot - V_model).^2));
O_RMS_EG(gal) = sqrt(mean((V_ele - V_model).^2));
O_MAD_MOND(gal) = mean(abs(OV_MOND - V_model));
O_MAD_Newton(gal) = mean(abs(OV_tot - V_model));
O_MAD_EG(gal) = mean(abs(V_ele - V_model));
subplot(1, 3, 1);
gname = append('Initial-',GalaxyName);

plotVelocities_SG(r_data,V_obs,V_err,r_model,V_model,OV_tot,OV_MOND,V_ele,V_ele_G,gname);
RMS_MOND(gal) = sqrt(mean((V_MOND - V_model).^2));
RMS_Newton(gal) = sqrt(mean((V_tot - V_model).^2));
RMS_EG(gal) = sqrt(mean((NV_ele - V_model).^2));
MAD_MOND(gal) = mean(abs(V_MOND - V_model));
MAD_Newton(gal) = mean(abs(V_tot - V_model));
MAD_EG(gal) = mean(abs(NV_ele - V_model));
subplot(1, 3, 2);
gname = append('Fitted-',GalaxyName);

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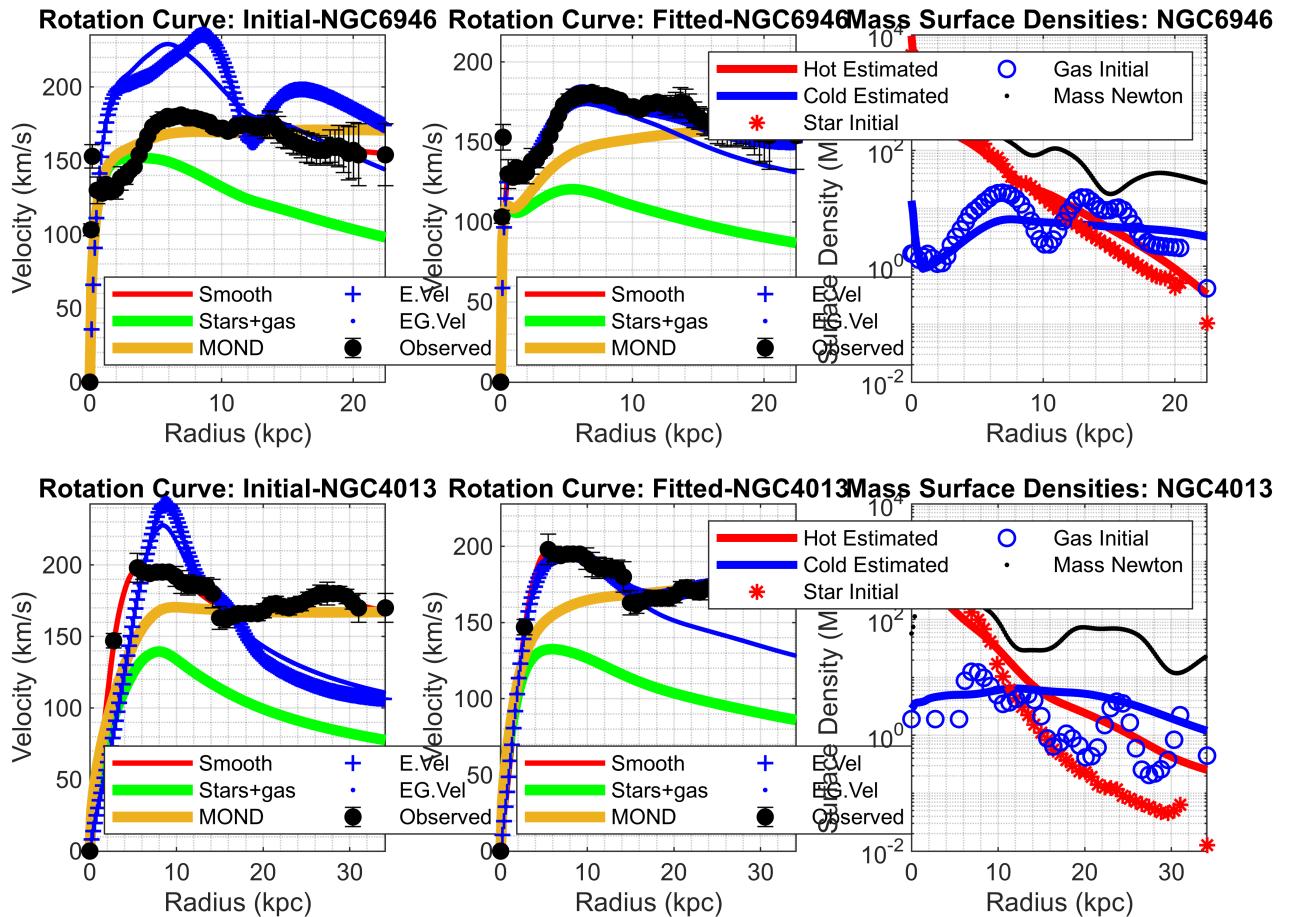
plotVelocities_SG(r_data,V_obs,V_err,r_model,V_model,V_tot,V_MOND,NV_ele,NV_ele_G,gn
ame);

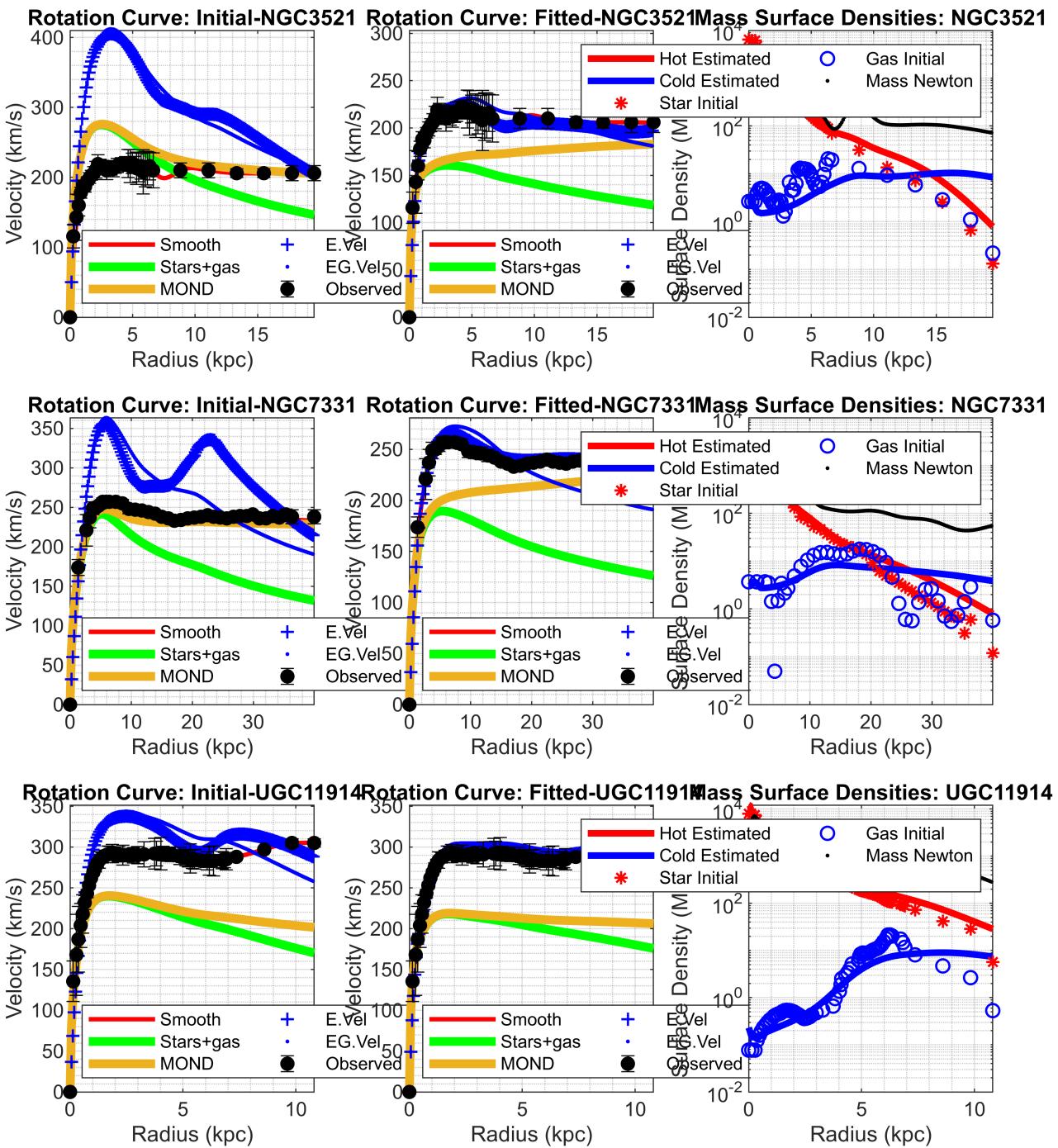
subplot(1, 3, 3);
semilogy(r_model,NSigma_S,"r-", 'LineWidth', 3, 'DisplayName', 'Hot Estimated')
hold on
semilogy(r_model,NSigma_H,"b-", 'LineWidth', 3, 'DisplayName', 'Cold Estimated')
semilogy(R_kpc,SigmaS,"r*", 'LineWidth', 1, 'DisplayName', 'Star Initial')
semilogy(R_kpc,SigmaG,"bo", 'LineWidth', 1, 'DisplayName', 'Gas Initial')
semilogy(r_model,Sigma_obs,"k.", 'LineWidth', 1, 'DisplayName', 'Mass Newton')
xlabel('Radius (kpc)');
ylabel('Surface Density ( $M_{\text{sun}}/\text{pc}^2$ )');
titles = append('Mass Surface Densities: ',galaxies(gal));
title(titles);
legend('Location', 'northeast','NumColumns',2);
xlim([0, max(r_data)]);
grid on;
grid minor;
hold off

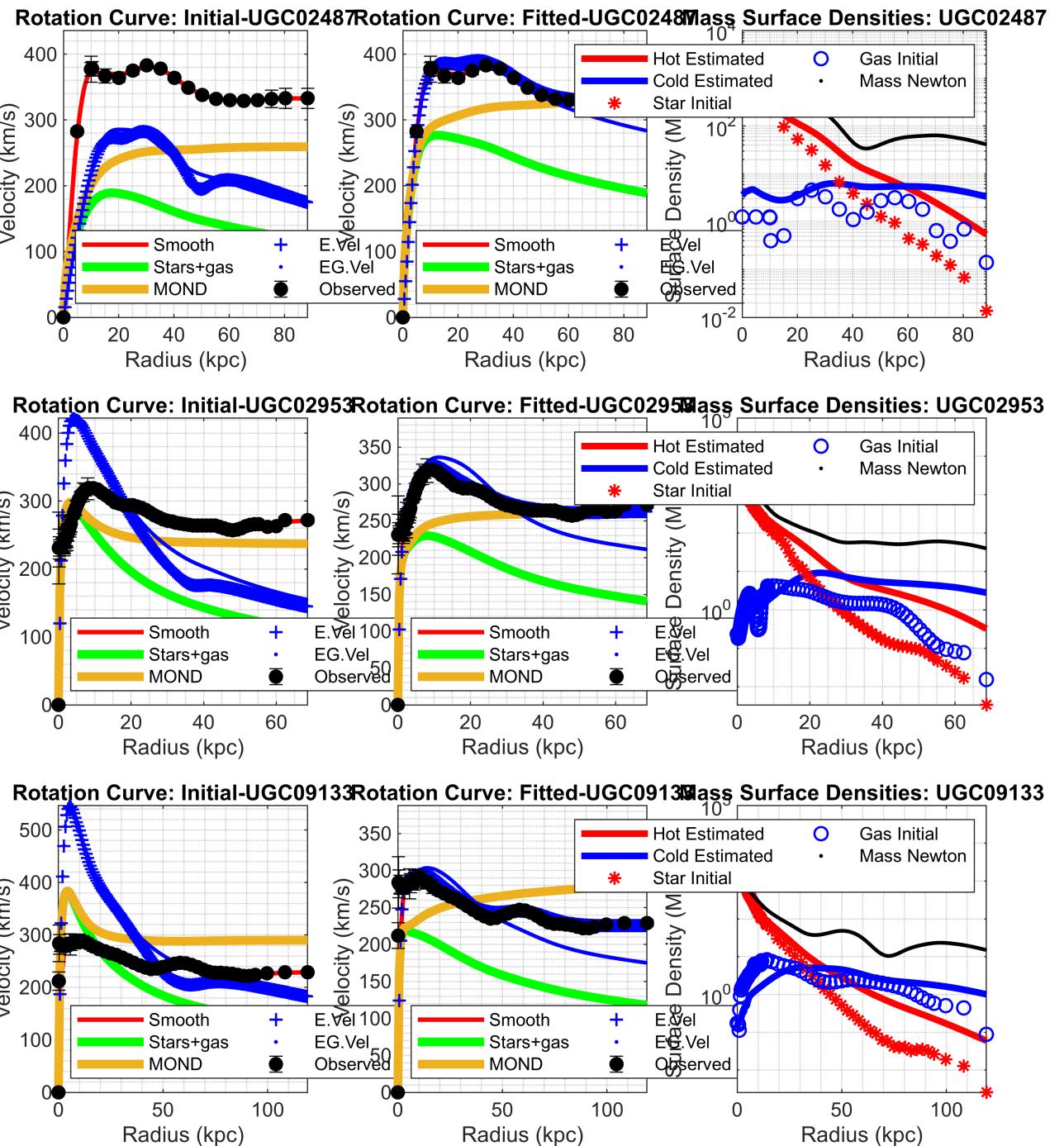
drawnow;

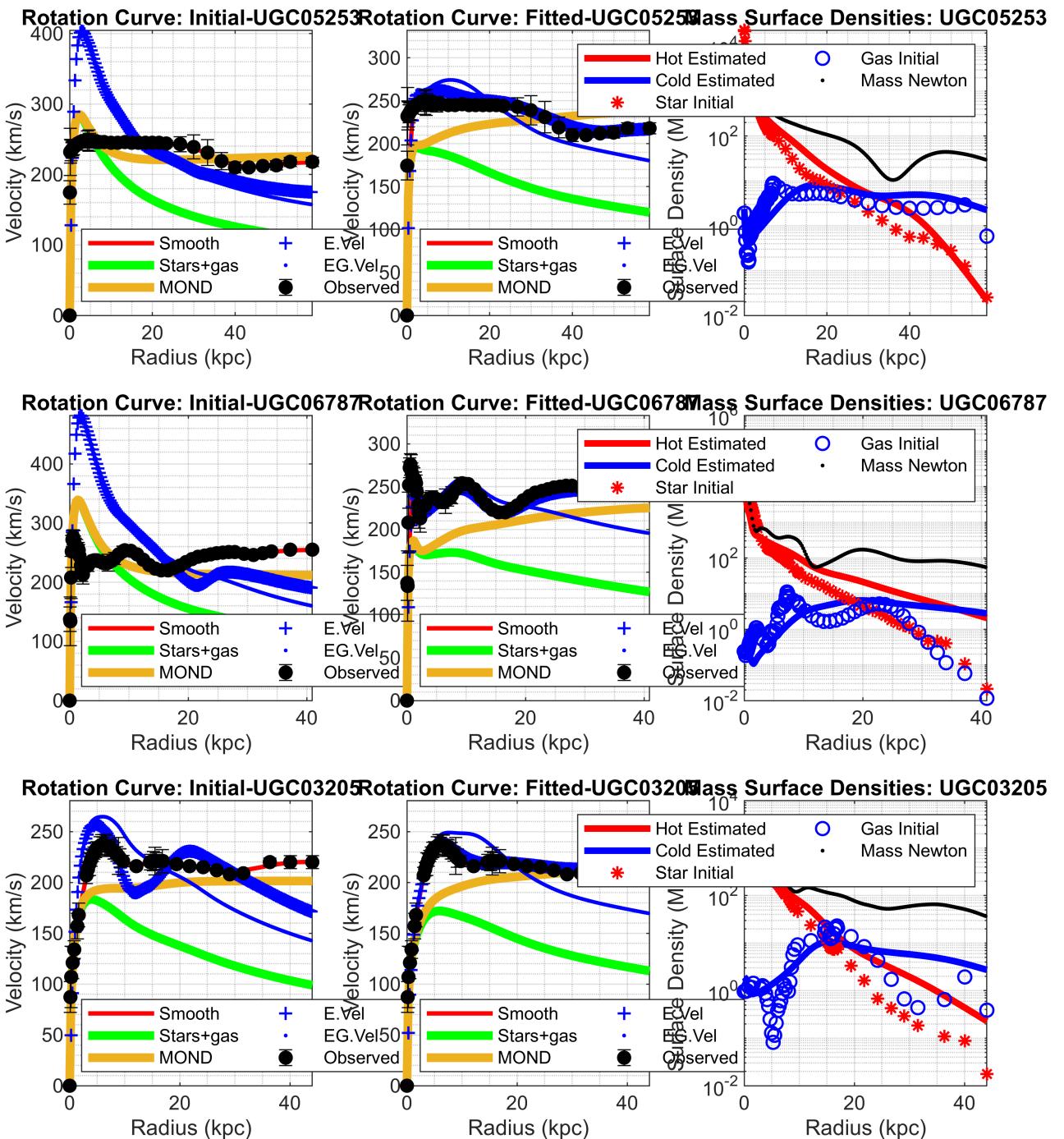
end

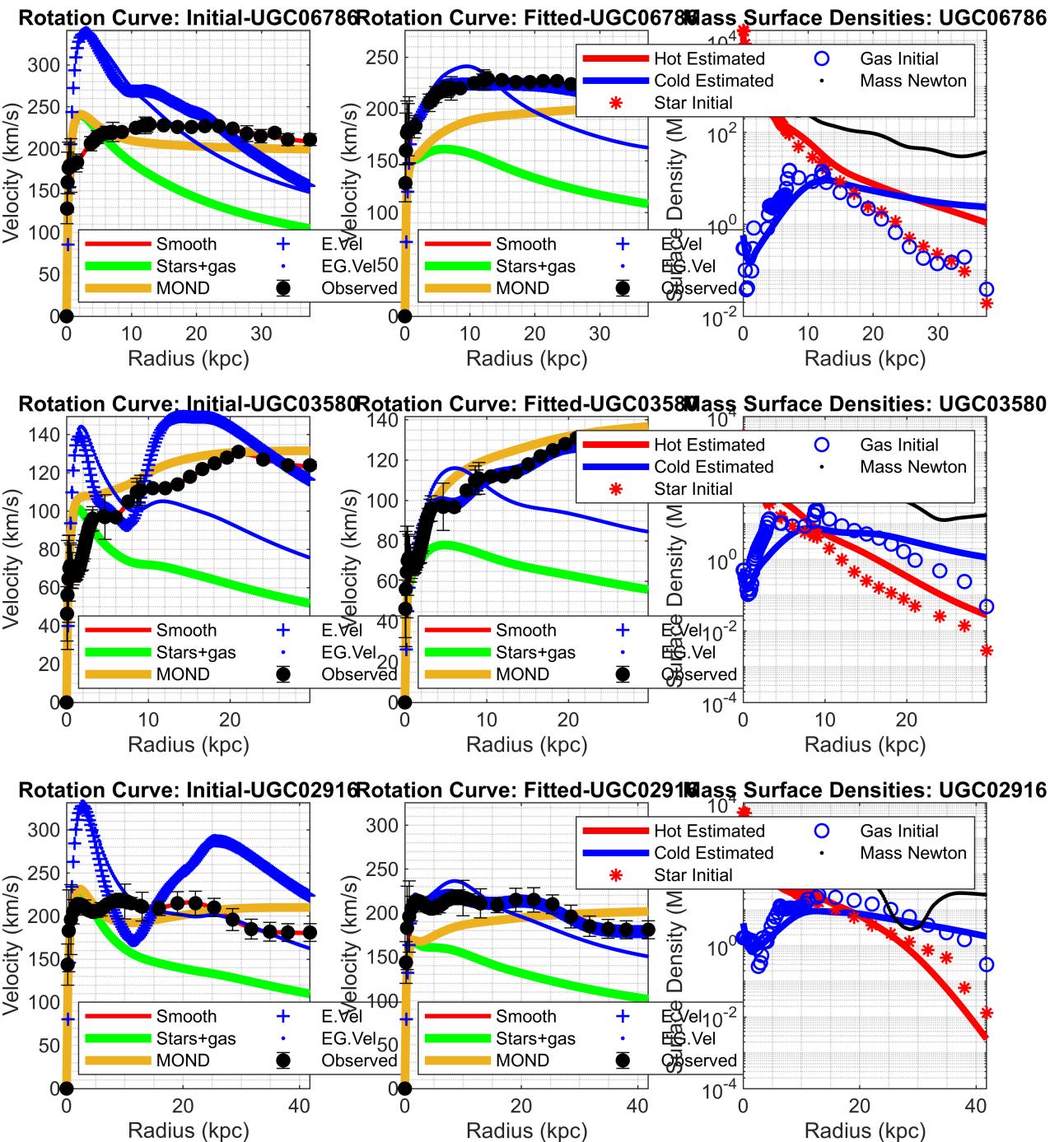
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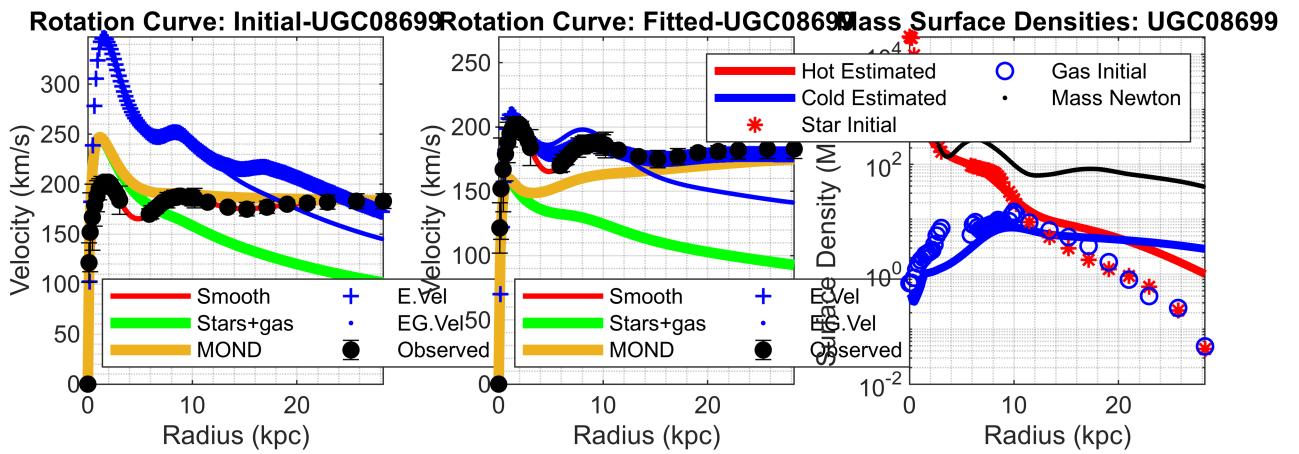






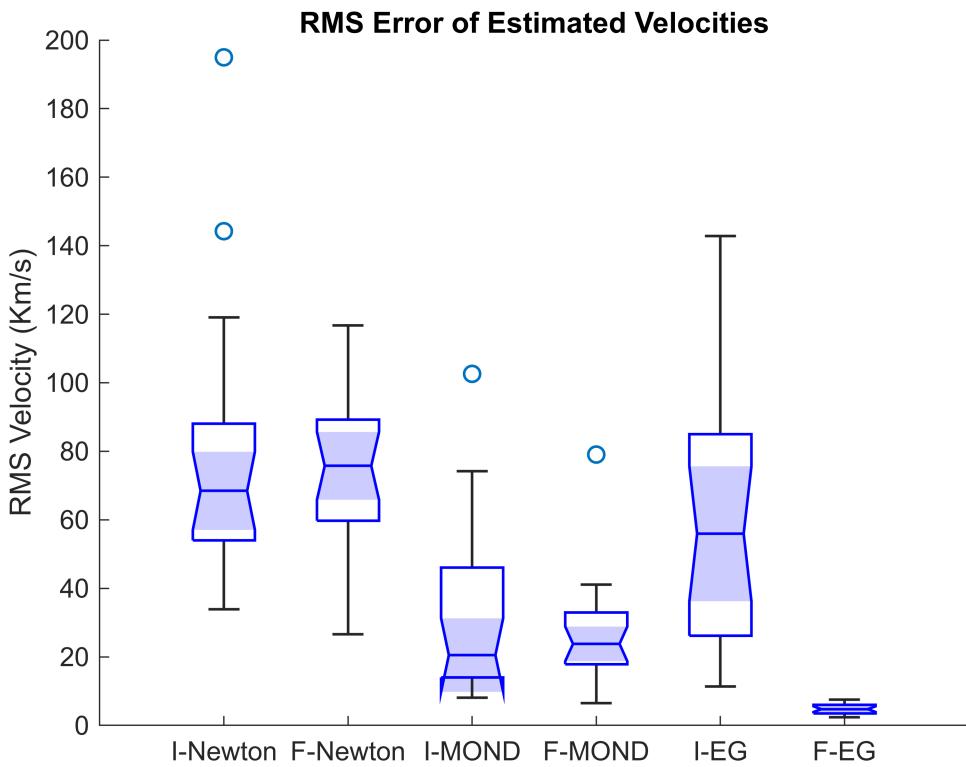






Box plot of the RMS error

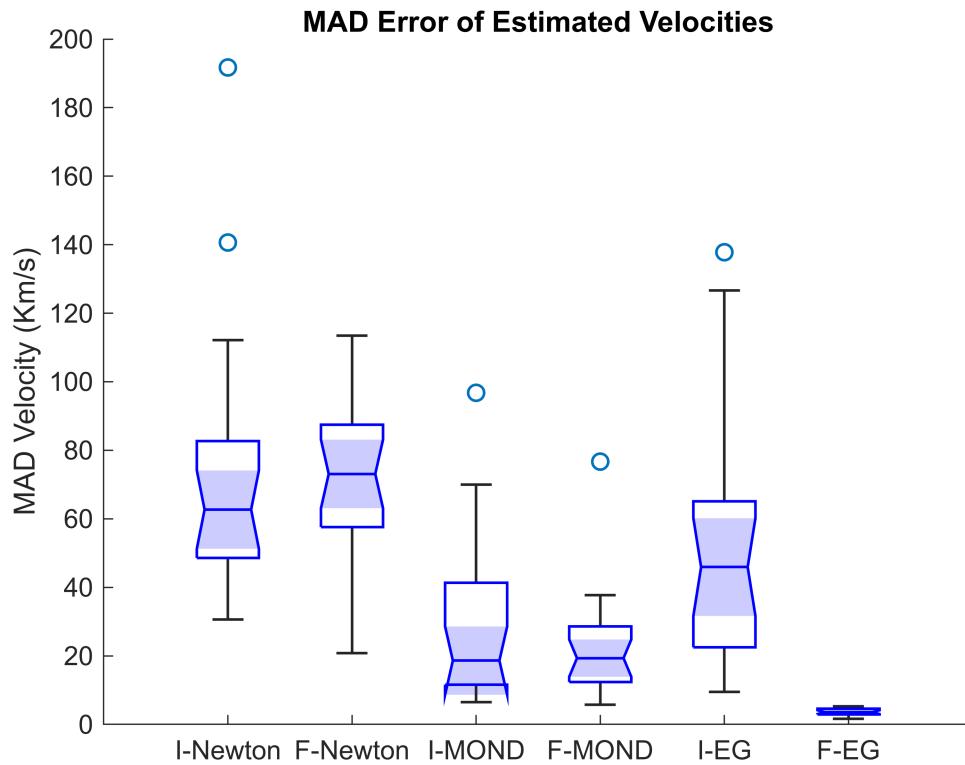
```
figure(gal+1)
RMSValues = [0_RMS_Newton,RMS_Newton,0_RMS_MOND,RMS_MOND,0_RMS_EG,RMS_EG];
rmsNames = ["I-Newton","F-Newton","I-MOND","F-MOND","I-EG","F-EG"];
b=boxchart(RMSValues,'Notch','on');
b.BoxFaceColor = ["b"];
xticklabels(rmsNames);
ylabel('RMS Velocity (Km/s)');
title("RMS Error of Estimated Velocities");
```



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figure(gal+2)
RMSValues = [O_MAD_Newton,MAD_Newton,O_MAD_MOND,MAD_MOND,O_MAD_EG,MAD_EG];
rmsNames = ["I-Newton","F-Newton","I-MOND","F-MOND","I-EG","F-EG"];
b=boxchart(RMSValues,'Notch','on');
b.BoxFaceColor = ["b"];
xticklabels(rmsNames);
ylabel('MAD Velocity (Km/s)');
title("MAD Error of Estimated Velocities");

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The total mass of galaxies

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figure(gal+3)
totBaryonicNewton = totGalaxyMass(:,2) + totGalaxyMass(:,3);
totBaryonicEG = totGalaxyMass(:,4) + totGalaxyMass(:,5);

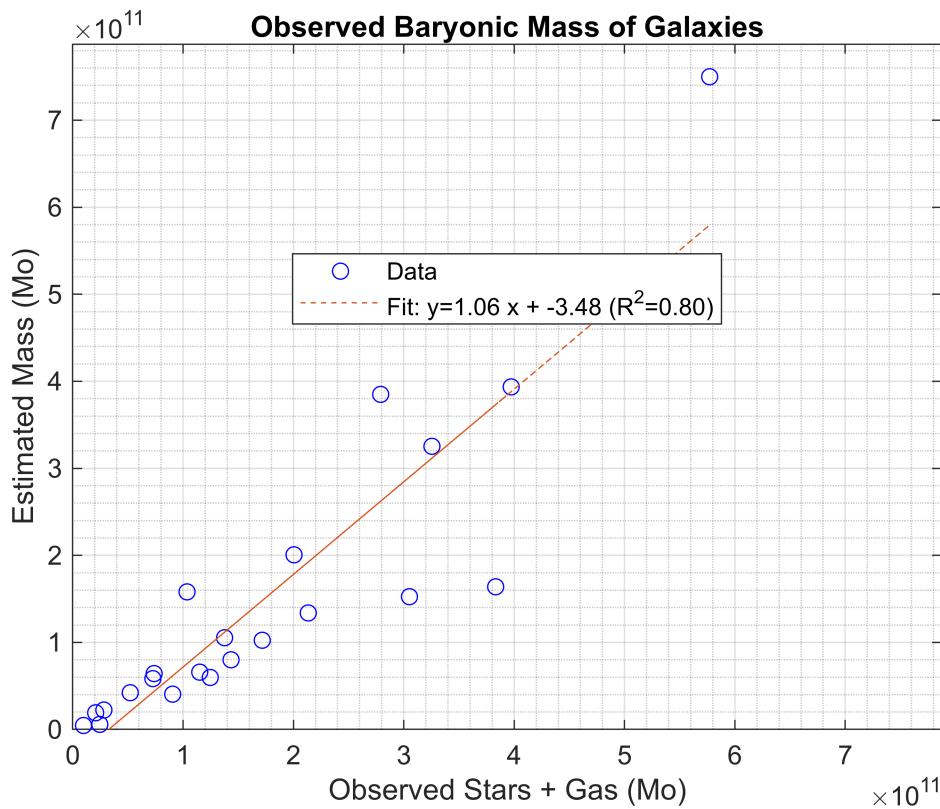
X = [ones(length(totBaryonicNewton),1) totBaryonicNewton];
b = X\totBaryonicEG;
EGCalc2 = X*b;
Rsq2 = 1 - sum((totBaryonicEG - EGCalc2).^2)/sum((totBaryonicEG -
mean(totBaryonicEG)).^2);
paramS = sprintf("Fit: y=%4.2f x + %4.2f (R^2=%4.2f)",b(2),b(1)/1.0e10,Rsq2);
plot(totBaryonicNewton,totBaryonicEG,"bo");
hold on
plot(totBaryonicNewton,EGCalc2,'--');
ylabel('Estimated Mass (Mo)');
xlabel('Observed Stars + Gas (Mo)');

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```

title("Observed Baryonic Mass of Galaxies");
legend('Data',paramS,'Location','best');
grid on;
grid minor;
mvalues = 1.05*max([totBaryonicNewton;totBaryonicEG]);
xlim([0, mvalues]);
ylim([0, mvalues]); % Enforce similar range
hold off

```



```

figure(gal+4)
totBaryonicNewton = totGalaxyMass(:,1) + totGalaxyMass(:,3);
totBaryonicEG = totGalaxyMass(:,4) + totGalaxyMass(:,5);

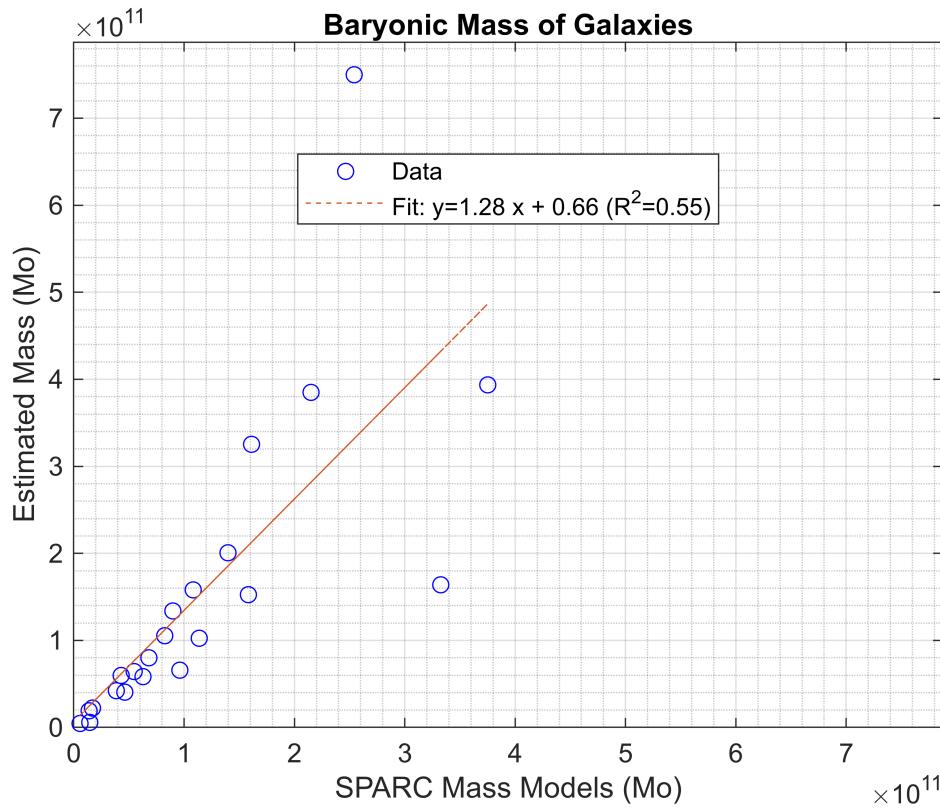
X = [ones(length(totBaryonicNewton),1) totBaryonicNewton];
b = X\totBaryonicEG;
EGCalc2 = X*b;
Rsq2 = 1 - sum((totBaryonicEG - EGCalc2).^2)/sum((totBaryonicEG -
mean(totBaryonicEG)).^2);
paramS = sprintf("Fit: y=%4.2f x + %4.2f (R^2=%4.2f)",b(2),b(1)/1.0e10,Rsq2);
plot(totBaryonicNewton,totBaryonicEG,"bo");
hold on
plot(totBaryonicNewton,EGCalc2,'--');
ylabel('Estimated Mass (Mo)');
xlabel('SPARC Mass Models (Mo)');
title("Baryonic Mass of Galaxies");
legend('Data',paramS,'Location','best');

```

```

grid on;
grid minor;
mvalues = 1.05*max([totBaryonicNewton;totBaryonicEG]);
xlim([0, mvalues]);
ylim([0, mvalues]); % Enforce similar range
hold off

```



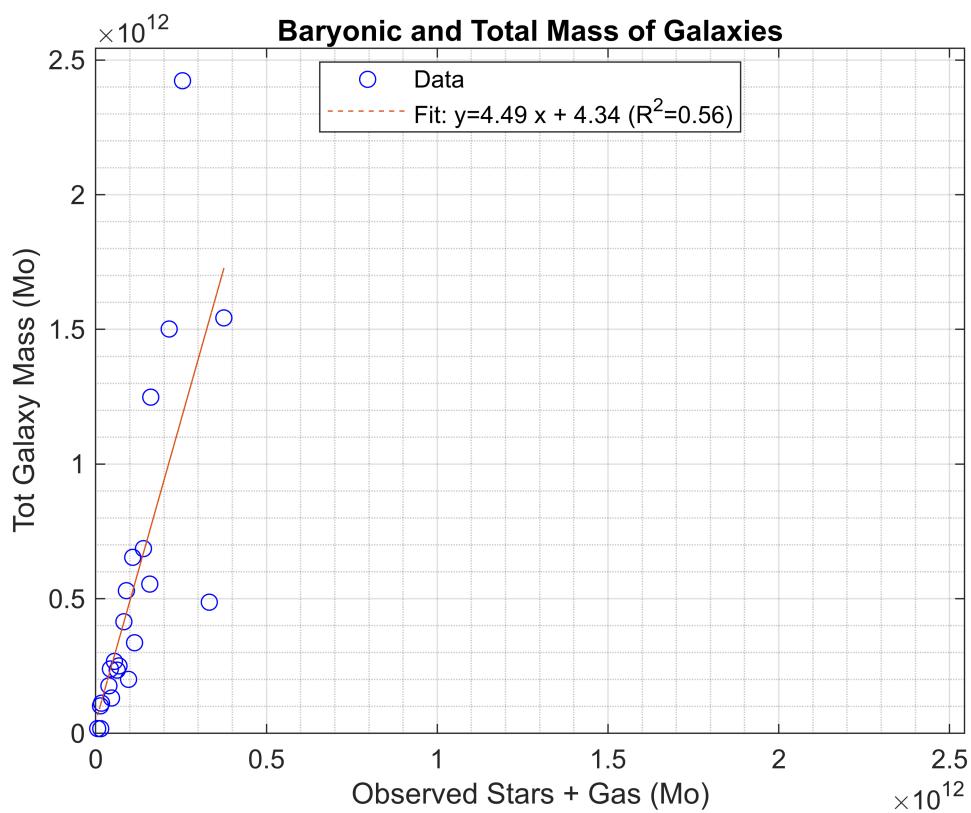
```

figure(gal+5)
totObsNewton = totGalaxyMass(:,6);

X = [ones(length(totBaryonicNewton),1) totBaryonicNewton];
b = X\totObsNewton;
EGCalc2 = X*b;
Rsq2 = 1 - sum((totObsNewton - EGCalc2).^2)/sum((totObsNewton -
mean(totObsNewton)).^2);
paramS = sprintf("Fit: y=%4.2f x + %4.2f (R^2=%4.2f)",b(2),b(1)/1.0e10,Rsq2);
plot(totBaryonicNewton,totObsNewton,"bo");
hold on
plot(totBaryonicNewton,EGCalc2, '--');
ylabel('Tot Galaxy Mass (Mo)');
xlabel('Observed Stars + Gas (Mo)');
title("Baryonic and Total Mass of Galaxies");
legend('Data',paramS,'Location','best');
grid on;
grid minor;
mvalues = 1.05*max([totBaryonicNewton;totObsNewton]);

```

```
xlim([0, mvalues]);  
ylim([0, mvalues]); % Enforce similar range  
hold off
```



```
save("SPARC_22_Galaxies.mat");
```