In [ ]:
```
import matplotlib
from helper_functions import datamaker
from scipy.integrate import quad
from scipy.interpolate import griddata
import numpy as np
import matplotlib.pyplot as plt
from sympy import *
import pickle
import os
from matplotlib.ticker import FormatStrFormatter

# Defining the Observables
q = Symbol('q')
omega = Symbol('\Omega')
sigma = Symbol('\Sigma')
sigmatot = Symbol('Sigma_tot')
sigmasfr = Symbol('Sigma_SFR')
T = Symbol('T')

# Defining the Constants
gamma = Symbol('gamma')
boltz = Symbol('k_B')
mu = Symbol('mu')
mh = Symbol('m_H')

# Defining the general parameters
u = Symbol('u')
tau = Symbol('tau')
l = Symbol('l')
h = Symbol('h')

# conversion factors
pc_kpc = 1e3  # number of pc in one kpc
cm_km = 1e5  # number of cm in one km
cm_kpc = 3.086e+21  # number of centimeters in one parsec
s_Myr = 1e+6*(365*24*60*60)  # megayears to seconds
deg_rad = 180e0/np.pi
arcmin_deg = 60e0
arcsec_deg = 3600e0

###################################################################################
###################################################################################
current_directory=os.path.abspath(os.curdir)
#reading the parameters
params = {}
with open(current_directory+ '\parameter_file.in', 'r') as FH:
    for file in FH.readlines():
        line = file.strip()
        try:
            par_name, value = line.split('=')
        except ValueError:
            print("Record: ", line)
            raise Exception(
                "Failed while unpacking. Not enough arguments to supply.")
```

```
        try:
            params[par_name] = np.float64(value)
        except ValueError:
            num, denom = value.split('/')
            params[par_name] = np.float64(num) / np.float64(denom)

#################################################################################
os.chdir(current_directory)

# def choose_galaxy(name):
#     if name=="m33":
#         from data.data_magfield_observables_m33 import G_dat_Bord,G_dat_Breg,G_da

#         os.chdir(current_directory)
#         from data.data_conv_M33 import nandeleted_data,data_v_disp
#         corrected_radius,dat_sigmatot,dat_sigmaHI,dat_sigmaH2, dat_q, dat_omega,
#         dat_u=data_v_disp

#         with open(current_directory+r'\mag_observables_m33.pickle', 'rb') as f:
#             kpc_r, h_f, l_f, u_f, cs_f, alphak_f, tau_f, biso_f, bani_f, Bbar_f,
#     return G_dat_Bord,G_dat_Breg,G_dat_Btot,rmdat_tanpo,rm_errdat_tanpo,M_dat_pb,

# choose_galaxy('m33')
#################################################################################

# from data.data_magfield_observables_6946 import G_dat_Bord,G_dat_Breg,G_dat_Btot,
# from data.data_magfield_observables_m51 import G_dat_Bord,G_dat_Breg,G_dat_Btot,r
from data.data_magfield_observables_m33 import G_dat_Bord,G_dat_Breg,G_dat_Btot,rmd
# from data.data_magfield_observables_m31 import G_dat_Bord,G_dat_Breg,G_dat_Btot,R

#################################################################################
from get_magnetic_observables import omt, kah, taue_f, taur_f

#change file name here
with open(current_directory+r'\mag_observables_m33.pickle', 'rb') as f:
    kpc_r, h_f, l_f, u_f, cs_f, alphak_f, tau_f, biso_f, bani_f, Bbar_f, tanpB_f, t

os.chdir(current_directory)
with open(current_directory+r'\errors_quan.pickle', 'rb') as f:
     h_err, l_err, u_err, cs_err, alphak_err, tau_err, biso_err, bani_err, Bbar_err

os.chdir(current_directory+'\data')
with open('zip_data.pickle', 'rb') as f:
    kpc_r, data_pass = pickle.load(f)
#################################################################################

os.chdir(current_directory+'\expressions')
from expressions.magnetic_expressions import Dk, Dc

dkdc_f = datamaker((Dk/Dc), data_pass, h_f, tau_f, alphak_f)
alpham_f = alphak_f*((1/dkdc_f)-1)
alphasat_f = alphak_f + alpham_f
#################################################################################
#################################################################################

# M31
```

```
# os.chdir(current_directory)
# # from data.data_conv_M31 import kpc_r, dat_u,dat_u_warp
# from data.data_M31 import kpc_r, dat_u,dat_u_warp
# corrected_radius=kpc_r
##################################################################################

# M51
# os.chdir(current_directory)
# from data.data_m51 import nandeleted_data,vel_disp
# corrected_radius,dat_sigmatot,dat_sigmaHI,dat_sigmaH2, dat_q, dat_omega, dat_sigm
# dat_u=vel_disp #this has been interpolated in data.m51
##################################################################################
# M33
os.chdir(current_directory)
from data.data_conv_M33 import nandeleted_data,data_v_disp
corrected_radius,dat_sigmatot,dat_sigmaHI,dat_sigmaH2, dat_q, dat_omega, dat_sigmas
dat_u=data_v_disp
##################################################################################
# 6946
# os.chdir(current_directory)
# from data.data_6946 import nandeleted_data,vel_disp
# corrected_radius,dat_sigmatot,dat_sigmaHI,dat_sigmaH2, dat_q, dat_omega, dat_sigm
# dat_u=vel_disp
##################################################################################

os.chdir(current_directory)

pB = np.arctan(-tanpB_f)
pB_err = -tanpB_err/(1+tanpB_f**2)
pbb = np.arctan(tanpb_f)
pbb_err = tanpb_err/(1+tanpb_f**2)
pbo = (1/2)*((1+(2*Bbar_f*bani_f*np.cos(pbb-pB))/
              (bani_f**2+Bbar_f**2))*np.arctan((Bbar_f*np.sin(pB) + bani_f*np.sin(p
                                                ((Bbar_f*np.cos(pB)) + bani_f*np.cos
                                                         + (1-(2*Bbar_f*bani_f*np.co
                                                            (bani_f**2+Bbar_f**2))*n



def pogen(b, B, pb, pB, s):
    return (np.exp(-b**2/(2*s**2))/
            (np.sqrt(2*(np.pi))*s))*(1+(2*B*b*np.cos(pb-pB))/
                                     (b**2 + B**2))*np.arctan((B*np.sin(pB) + b*np.

brms = np.sqrt(np.average(bani_f**2))

h = 1e-8 #here h is the tolerance
def dpodbani(b, B, pb, pB, s):
    return (pogen(b, B, pb, pB, s+h)-pogen(b, B, pb, pB, s-h))/(2*h)
def dpodBbar(b, B, pb, pB, s):
    return (pogen(b, B+h, pb, pB, s)-pogen(b, B-h, pb, pB, s))/(2*h)
h = 0.01 #here h is the tolerance
def dpodpB(b, B, pb, pB, s):
    return (pogen(b, B, pb, pB+h, s)-pogen(b, B, pb, pB-h, s))/(2*h)
def dpodpb(b, B, pb, pB, s):
    return (pogen(b, B, pb+h, pB, s)-pogen(b, B, pb-h, pB, s))/(2*h)
```

```
def integrator(fn, interval = 1e-3):
    return np.array([quad(fn, 1e-11, 1e-9, args=(Bbar_f[i], pbb[i], pB[i], bani_f[i
              points=[-interval*brms, interval*brms])[0] for i in range(len(kpc_r)
pog = integrator(pogen)
inte = 1e-10
pog_err = np.array([quad(pogen, -inte, inte, args=(Bbar_f[i], pbb[i], pB[i], bani_f
                points=[-inte*brms, inte*brms])[1] for i in range(len(kpc_r))])
pog_err += np.sqrt((integrator(dpodbani,inte)*bani_err)**2 +(integrator(dpodBbar,in
                  +(integrator(dpodpB,inte)*pB_err)**2+(integrator(dpodpb,inte)*pbb

G_scal_Bbartot = np.sqrt(biso_f**2 + bani_f**2 + Bbar_f**2)
G_scal_Bbarreg = Bbar_f
G_scal_Bbarord = np.sqrt(bani_f**2 + Bbar_f**2)

G_scal_Bbartot_err = np.sqrt((biso_err*biso_f )**2+ (bani_err*bani_f)**2 + (Bbar_er
G_scal_Bbarreg_err = Bbar_err
G_scal_Bbarord_err = np.sqrt((bani_err*bani_f)**2 + (Bbar_err*Bbar_f)**2)/G_scal_Bb

os.chdir(current_directory)
```

```
Root found succesfully
Solved the magnetic expressions
```

In [ ]:

```
# len(corrected_radius)
# corrected_radius
```

In [ ]:

```
m = 2
dm = 2.5
fs = 15
lfs = 10
leg_textsize = 10
axis_textsize = 10
rc = {"font.family" : "serif",
      "mathtext.fontset" : "stix"}
plt.rcParams.update(rc)
plt.rcParams["font.serif"] = ["Times New Roman"] + plt.rcParams["font.serif"]
matplotlib.rc('xtick', labelsize=fs)
matplotlib.rc('ytick', labelsize=fs)
matplotlib.ticker.AutoMinorLocator(n=None)
plt.rcParams["xtick.minor.visible"] =  True
plt.rcParams["ytick.minor.visible"] =  True
plt.rcParams["legend.loc"] = 'upper right'
plt.rcParams["errorbar.capsize"] = 2
```

In [ ]:

```
#change axis params here
def axis_pars(ax):
    # ax.xaxis.set_ticks(np.arange(1,15, 1))
    ax.xaxis.set_ticks(np.arange(6,15, 1)) # for m31 only
    ax.xaxis.set_major_formatter(FormatStrFormatter('%g'))
    ax.tick_params(axis='both', which='minor',
                   labelsize=axis_textsize, colors='k', length=3, width=1)
    ax.tick_params(axis='both', which='major',
                   labelsize=axis_textsize, colors='k', length=5, width=1.25)
    ax.spines['top'].set_visible(False)
    ax.spines['right'].set_visible(False)
    ax.spines['bottom'].set_linewidth(2)
```

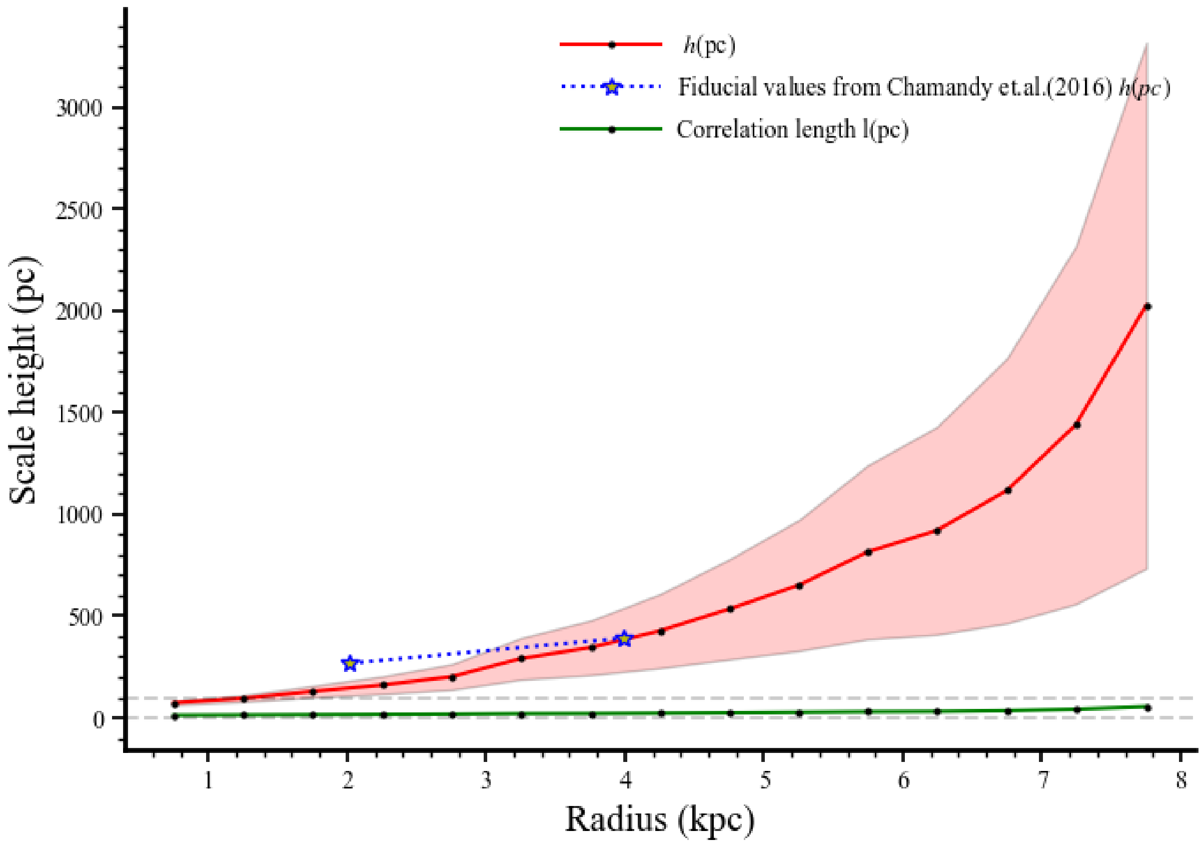
```
    ax.spines['left'].set_linewidth(2)
    ax.legend(fontsize=lfs, frameon=False, handlelength=4, ncol=1, prop={
            'size': leg_textsize, 'family': 'Times New Roman'}, fancybox=True, fram

def fill_error(ax, quan_f, quan_err, color = 'red', alpha = 0.2):
    ax.fill_between(kpc_r, (quan_f+quan_err), (quan_f-quan_err)
                    , alpha=alpha, edgecolor='k', facecolor=color, where = None, in
```

plotting h

In [ ]:

```
fig,ax = plt.subplots(nrows=1, ncols=1, figsize=(7, 5), tight_layout=True)
ax.plot(kpc_r, h_f*pc_kpc/cm_kpc, c='r', linestyle='-', mfc='k',
              mec='k', markersize=m, marker='o', label=r' $h$(pc)')
ax.plot(kpc_dat_r, pc_dat_h, c='b', linestyle='dotted',
              marker='*',mfc='y',mec='b',mew=1, markersize = 7, label=r'Fiducial va
ax.plot(kpc_r, l_f*pc_kpc/cm_kpc, c='g',
              linestyle='-', mfc='k', mec='k', markersize=m, marker='o', label=r'Co
# ax.plot(kpc_r, datamaker(lsn , data_pass, h_f, tau_f)*pc_kpc/cm_kpc,c = 'y',lines
ax.axhline(y=100, color='black', linestyle='--', alpha = 0.2)
# ax.set_yticks(list(plt.yticks()[0])+[100])
axis_pars(ax)
fill_error(ax, h_f*pc_kpc/cm_kpc, h_err*pc_kpc/cm_kpc)
ax.set_xlabel(r'Radius (kpc)', fontsize=fs)
ax.set_ylabel(r'Scale height (pc)', fontsize=fs)
ax.axhline(y=0, color='black', linestyle='--', alpha = 0.2)

hf=h_f*(pc_kpc/cm_kpc)
lf=l_f*(pc_kpc/cm_kpc)
index_sup = np.where(kpc_r== 8.75)
index_sub = np.where(kpc_r== 14.25)
print('h sup',hf[index_sup],kpc_r[index_sup])
print(hf[index_sub],kpc_r[index_sub])
print('l sup',lf[index_sup],kpc_r[index_sup])
print(lf[index_sub],kpc_r[index_sub])

print(hf)
print(kpc_r)
# plt.savefig(r'D:\Documents\Gayathri_college\MSc project\codes\MSc.-Thesis\plots\M
```

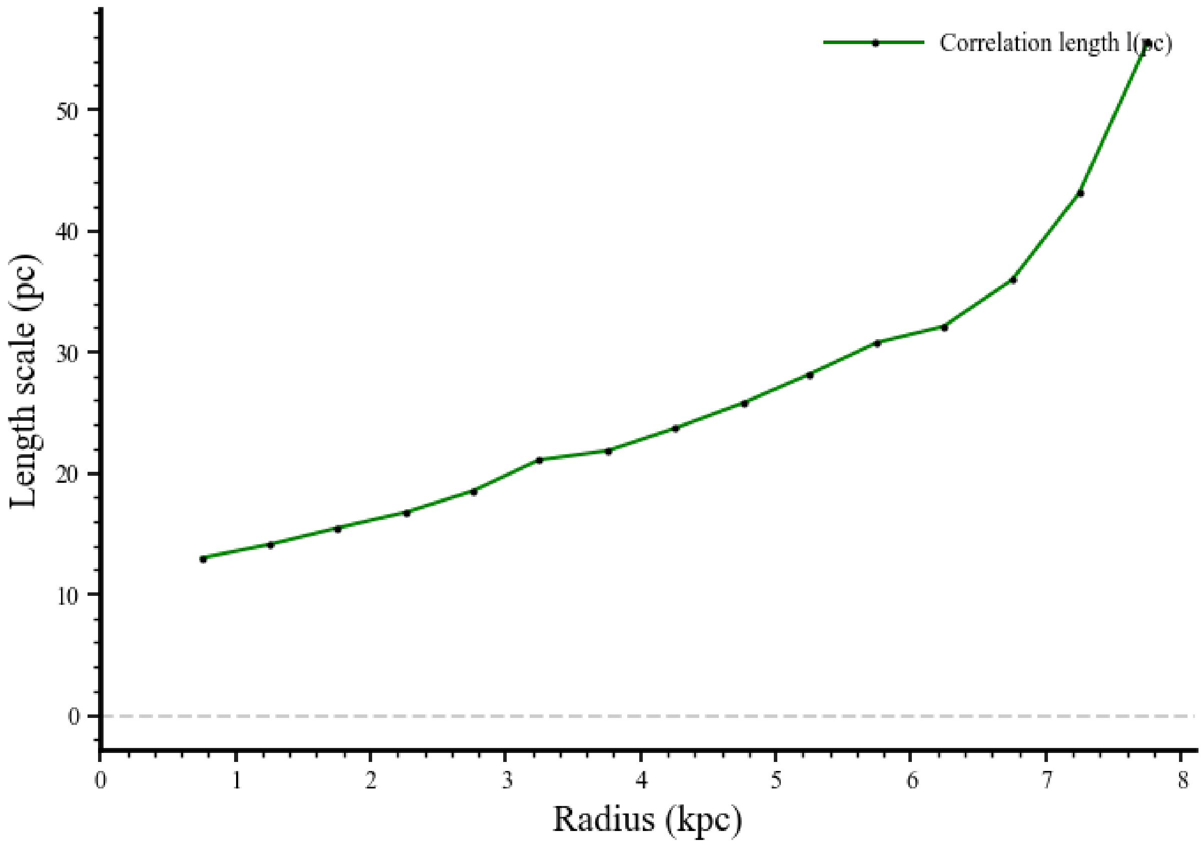
```
h sup [] []
[] []
l sup [] []
[] []
[  73.8519412    96.18829164  130.21052643  162.14547127  202.4468964
  291.39103913  345.81401176  427.50815975  536.31849034  652.4219757
  815.33705138  919.97928364 1116.96555971 1439.26292882 2026.28743756]
[0.7504 1.257  1.752  2.259  2.754  3.249  3.756  4.251  4.758  5.253
 5.748  6.243  6.75   7.245  7.752 ]
```



In [ ]:

```
fig,ax = plt.subplots(nrows=1, ncols=1, figsize=(7, 5), tight_layout=True)

ax.plot(kpc_r, l_f*pc_kpc/cm_kpc, c='g',
              linestyle='-', mfc='k', mec='k', markersize=m, marker='o', label=r'Co
# ax.plot(kpc_r, datamaker(lsn , data_pass, h_f, tau_f)*pc_kpc/cm_kpc,c = 'y',lines
# ax.axhline(y=100, color='black', linestyle='--', alpha = 0.2)
# ax.set_yticks(list(plt.yticks()[0])+[100])
axis_pars(ax)
# fill_error(ax, h_f*pc_kpc/cm_kpc, h_err*pc_kpc/cm_kpc)
ax.set_xlabel(r'Radius (kpc)', fontsize=fs)
ax.set_ylabel(r'Length scale (pc)', fontsize=fs)
ax.axhline(y=0, color='black', linestyle='--', alpha = 0.2)

print(l_f*pc_kpc/cm_kpc)
# plt.savefig(r'D:\Documents\Gayathri_college\MSc project\codes\MSc.-Thesis\plots\M
```

```
[12.99508395 14.11503177 15.45832802 16.74949164 18.50921132 21.09374517
 21.84143254 23.68321073 25.78622327 28.17967552 30.76376418 32.10987703
 35.95526555 43.09598066 55.55779235]
```



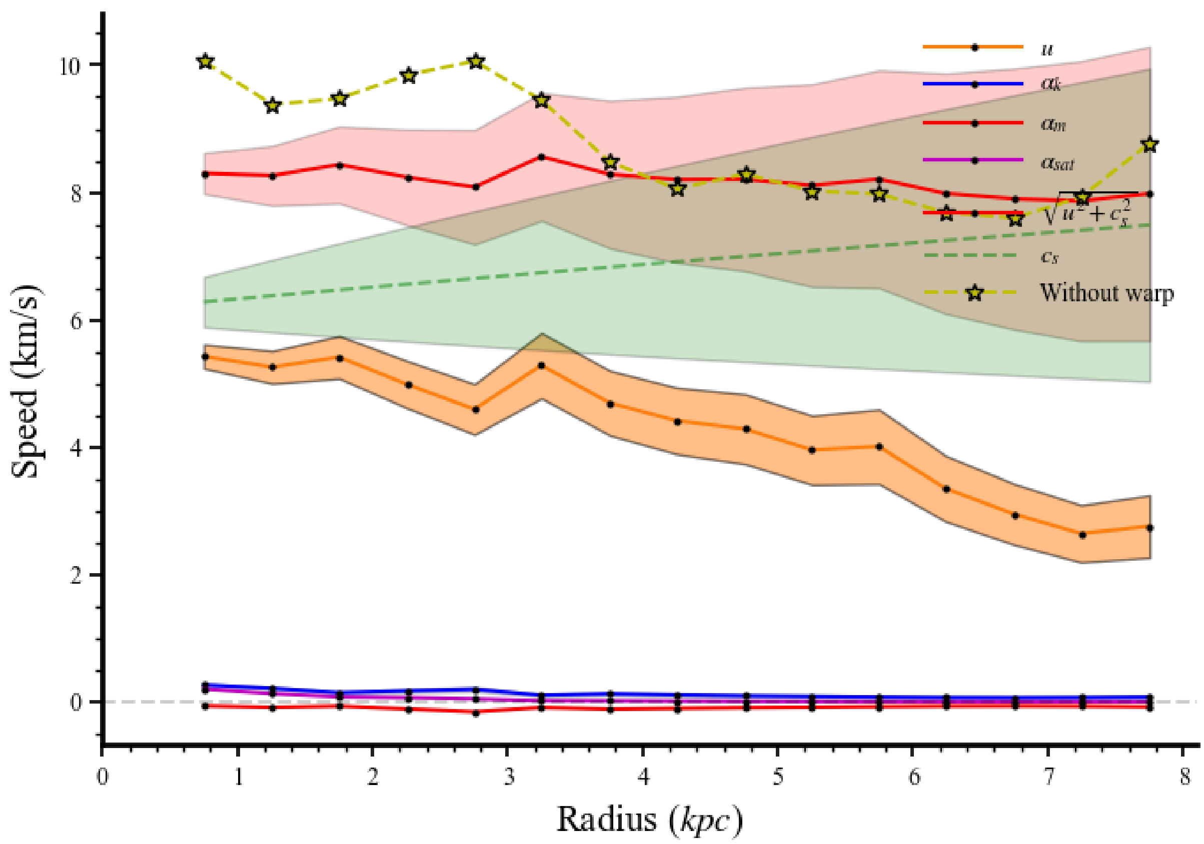
plotting u

In [ ]:
```
fig,ax = plt.subplots(nrows=1, ncols=1, figsize=(7, 5), tight_layout=True)
ax.plot(kpc_r, u_f/cm_km, color='tab:orange', marker='o', mfc='k',
              mec='k', markersize=m, label=r'$u$')
fill_error(ax, u_f/cm_km,u_err/cm_km, 'tab:orange', 0.5)

ax.plot(kpc_r, alphak_f/cm_km, color='b', marker='o',
              mfc='k', mec='k', markersize=m, label=r'$\alpha_k$')
fill_error(ax, alphak_f/cm_km,alphak_err/cm_km, 'blue')

ax.plot(kpc_r, alpham_f/cm_km, color='r', marker='o',
              mfc='k', mec='k', markersize=m, label=r'$\alpha_m$')
ax.plot(kpc_r, alphasat_f/cm_km, color='m', marker='o',
              mfc='k', mec='k', markersize=m, label=r'$\alpha_{sat}$')

sig = np.sqrt(u_f**2 + (cs_f)**2)
ax.plot(kpc_r, sig /
              cm_km, color='r', marker='o', mfc='k', mec='k', markersize=m, label=r
fill_error(ax, sig /cm_km,np.sqrt((u_f*u_err)**2 + (cs_f*cs_err)**2)/(sig*cm_km), '

ax.plot(kpc_r, cs_f /
              cm_km, color='g', linestyle='--', label=r'$c_s$', alpha = 0.5)
fill_error(ax, cs_f/cm_km,cs_err/cm_km, 'green')

ax.plot(corrected_radius, dat_u,
              c='y', linestyle='--', label='Without warp',alpha = 1,marker='*',mfc=
```

```
ax.axhline(y=0, color='black', linestyle='--', alpha = 0.2)

#next line is for warped u data for M31
# ax.plot(kpc_r, dat_u_warp,
#              c='tab:cyan',  linestyle='dashdot', label='With warp', alpha = 0.3,
axis_pars(ax)


uf=u_f/cm_km
csf=cs_f/cm_km
sigf=sig /cm_km
# index_sup = np.where(kpc_r== 8.75)
# index_sub = np.where(kpc_r== 14.25)
# print('sup u',uf[index_sup],kpc_r[index_sup])
# print(uf[index_sub],kpc_r[index_sub])
# print('sup cs',csf[index_sup],kpc_r[index_sup])
# print(csf[index_sub],kpc_r[index_sub])
# print('sup sig',sigf[index_sup],kpc_r[index_sup])
# print(sigf[index_sub],kpc_r[index_sub])
# print('************************************************************************
akf=alphak_f/cm_km
amf=alpham_f/cm_km
asf=alphasat_f/cm_km
# index_sup = np.where(kpc_r== 8.75)
# index_sub = np.where(kpc_r== 14.25)
# print('sup ak',akf[index_sup],kpc_r[index_sup])
# print(akf[index_sub],kpc_r[index_sub])
# print('sup am',amf[index_sup],kpc_r[index_sup])
# print(amf[index_sub],kpc_r[index_sub])
# print('sup as',asf[index_sup],kpc_r[index_sup])
# print(asf[index_sub],kpc_r[index_sub])
# print('************************************************************************

print('uf',uf)
print('cs',csf)
print('sig',sigf)
print('************************************************************************
print('alpha_k',akf)
print('alpha_m',amf)
print('alpha_s',asf)


#ax.set_ylim(0)
ax.set_xlabel(r'Radius ($kpc$)', fontsize=fs)
ax.set_ylabel(r'Speed (km/s)',  fontsize=fs)

# plt.savefig(r'D:\Documents\Gayathri_college\MSc project\codes\MSc.-Thesis\plots\M

# print(sigf)
```

```
uf [5.42817011 5.25962972 5.41701407 4.98518125 4.59901381 5.28618627
 4.69640555 4.417629   4.28717952 3.95802619 4.01205443 3.35216228
 2.94973015 2.64537639 2.75897062]
cs [6.28401545 6.37906034 6.47058056 6.56299656 6.6519866  6.73980174
 6.82857515 6.91414785 7.00071078 7.0842045  7.16672556 7.24830719
 7.33092546 7.4106997  7.49152729]
sig [8.30384736 8.26777574 8.43874719 8.24165978 8.0870176  8.56555268
 8.28768144 8.20493062 8.2091327  8.11491988 8.21331456 7.98592193
 7.90211213 7.86870296 7.98341405]
*************************************************************************************
**********************
alpha_k [0.26933148 0.21521724 0.14732222 0.17671731 0.20130974 0.10569958
 0.12820271 0.11102165 0.09624426 0.08702029 0.07737367 0.06904663
 0.06645139 0.06942217 0.077253  ]
alpha_m [-0.06409552 -0.08539896 -0.06719159 -0.10981134 -0.15407226 -0.08721663
 -0.11214256 -0.1008529  -0.09027966 -0.08340571 -0.07507797 -0.067842
 -0.06572691 -0.06900116 -0.076942  ]
alpha_s [0.20523596 0.12981829 0.08013063 0.06690597 0.04723748 0.01848295
 0.01606014 0.01016875 0.0059646  0.00361459 0.0022957  0.00120463
 0.00072448 0.000421   0.000311  ]
```

Out[ ]: Text(0, 0.5, 'Speed (km/s)')

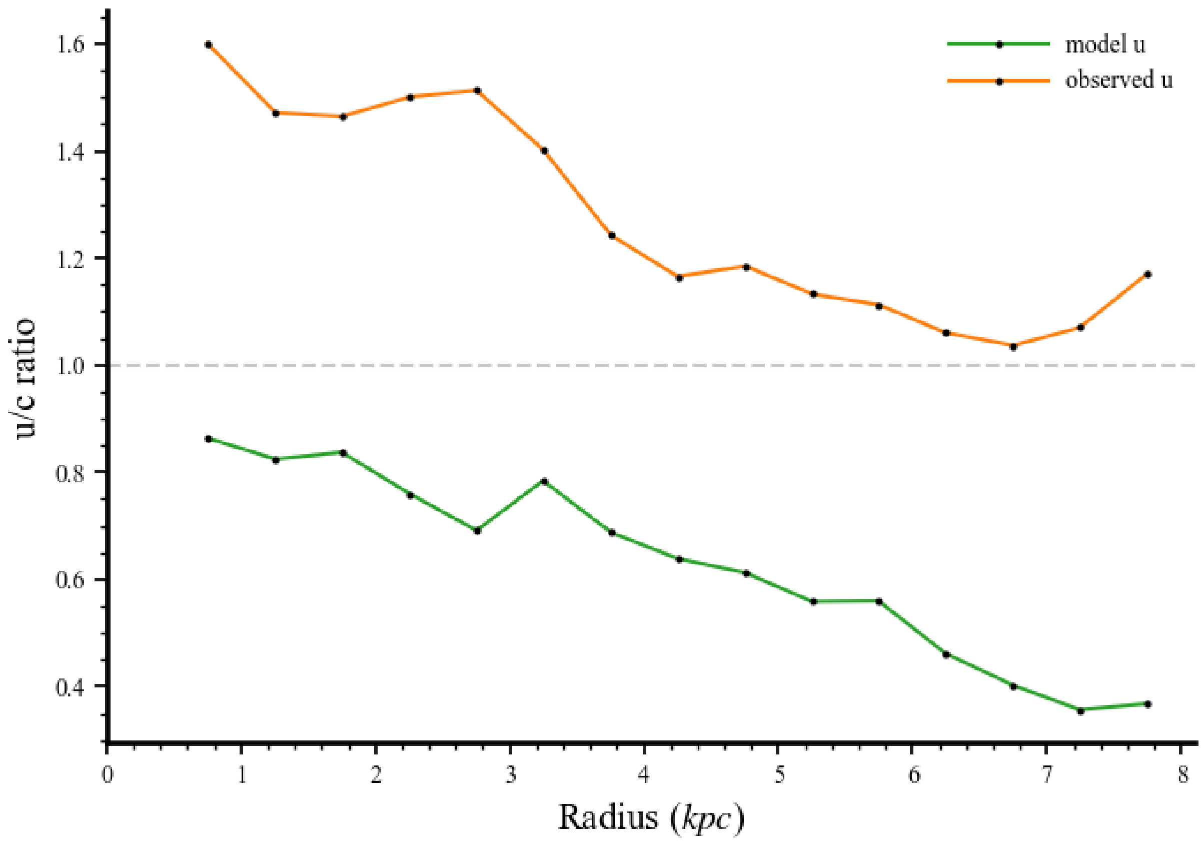


In [ ]:

```
fig,ax = plt.subplots(nrows=1, ncols=1, figsize=(7, 5), tight_layout=True)
ax.plot(kpc_r, (u_f/cm_km)/(cs_f /cm_km), color='tab:green', marker='o', mfc='k',
              mec='k', markersize=m, label=r'model u')
ax.plot(kpc_r, (dat_u)/(cs_f /cm_km), color='tab:orange', marker='o', mfc='k',
              mec='k', markersize=m, label=r'observed u')

ax.axhline(y=1, color='black', linestyle='--', alpha = 0.2)
```

```
axis_pars(ax)

#ax.set_ylim(0)
ax.set_xlabel(r'Radius ($kpc$)', fontsize=fs)
ax.set_ylabel(r'u/c ratio',  fontsize=fs)

# plt.savefig(r'D:\Documents\Gayathri_college\MSc project\codes\MSc.-Thesis\plots\M
```

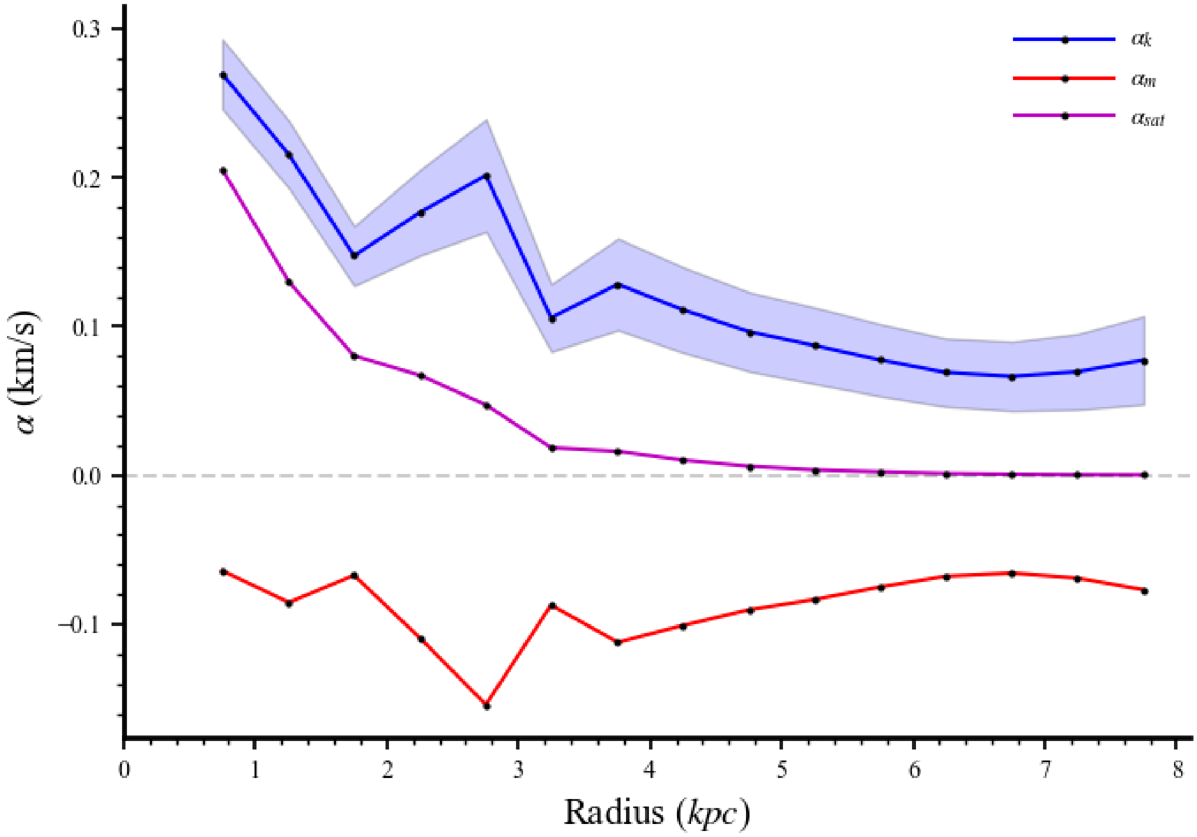
Out[ ]: Text(0, 0.5, 'u/c ratio')



In [ ]:

```
fig,ax = plt.subplots(nrows=1, ncols=1, figsize=(7, 5), tight_layout=True)

ax.plot(kpc_r, alphak_f/cm_km, color='b', marker='o',
              mfc='k', mec='k', markersize=m, label=r'$\alpha_k$')
fill_error(ax, alphak_f/cm_km,alphak_err/cm_km, 'blue')

ax.plot(kpc_r, alpham_f/cm_km, color='r', marker='o',
              mfc='k', mec='k', markersize=m, label=r'$\alpha_m$')
ax.plot(kpc_r, alphasat_f/cm_km, color='m', marker='o',
              mfc='k', mec='k', markersize=m, label=r'$\alpha_{sat}$')

axis_pars(ax)
ax.axhline(y=0, color='black', linestyle='--', alpha = 0.2)

# ax.set_ylim(0)
ax.set_xlabel(r'Radius ($kpc$)', fontsize=fs)
ax.set_ylabel(r'$\alpha$ (km/s)',  fontsize=fs)

# plt.savefig(r'D:\Documents\Gayathri_college\MSc project\codes\MSc.-Thesis\plots\M
```

Out[ ]: Text(0, 0.5, '$\\alpha$ (km/s)')

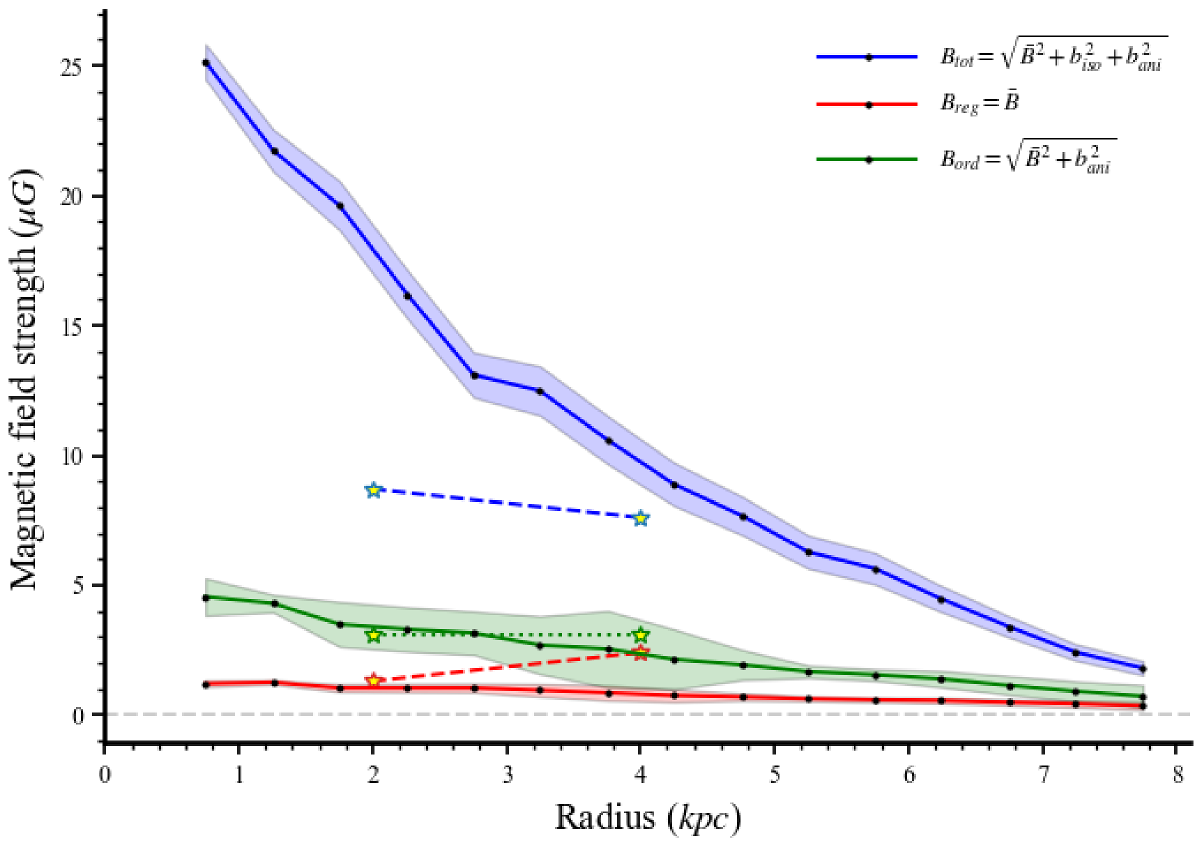


plotting magnetic fields

In [ ]:
```
# without observational data

# fig,ax = plt.subplots(nrows=1, ncols=1, figsize=(7, 5), tight_layout=True)
# ax.plot(kpc_r, G_scal_Bbartot*1e+6, c='b', linestyle='-', marker='o', mfc='k', me
#                markersize=m, label=r' $B_{tot}=\sqrt{\bar{B}^2+b_{iso}^2+b_{ani}^2
# fill_error(ax, G_scal_Bbartot*1e+6,G_scal_Bbartot_err*1e+6, 'b')

# ax.plot(kpc_r, G_scal_Bbarreg*1e+6, c='r', linestyle='-', marker='o',
#                mfc='k', mec='k', markersize=m, label=r' $B_{reg} = \bar{B}$')
# fill_error(ax, G_scal_Bbarreg*1e+6,G_scal_Bbarreg_err*1e+6, 'r', 0.2)


# ax.plot(kpc_r, G_scal_Bbarord*1e+6, c='green', linestyle='-', marker='o', mfc='k'
#                mec='k', markersize=m, label=r' $B_{ord} = \sqrt{\bar{B}^2+b_{ani}^
# fill_error(ax, G_scal_Bbarord*1e+6,G_scal_Bbarord_err*1e+6, 'g', 0.2)

# ax.axhline(y=0, color='black', linestyle='--', alpha = 0.2)

# ax.set_xlabel(r'Radius ($kpc$)', fontsize=fs)
# ax.xaxis.set_ticks(np.arange(4, 9, 1))
# ax.xaxis.set_major_formatter(FormatStrFormatter('%g'))
# ax.set_ylabel('Magnetic field strength ($\mu G$)', fontsize=fs)
# axis_pars(ax)
```

In [ ]:
```
fig,ax = plt.subplots(nrows=1, ncols=1, figsize=(7, 5), tight_layout=True)
ax.plot(mrange, G_dat_Btot, c='b', linestyle='--', marker='*',mfc='yellow',mec='tab
ax.plot(kpc_r, G_scal_Bbartot*1e+6, c='b', linestyle='-', marker='o', mfc='k', mec=
              markersize=m, label=r' $B_{tot}=\sqrt{\bar{B}^2+b_{iso}^2+b_{ani}^2}$
fill_error(ax, G_scal_Bbartot*1e+6,G_scal_Bbartot_err*1e+6, 'b')

ax.plot(mrange, G_dat_Breg, c='r', linestyle='--', marker='*',mfc='yellow',mec='tab
ax.plot(kpc_r, G_scal_Bbarreg*1e+6, c='r', linestyle='-', marker='o',
              mfc='k', mec='k', markersize=m, label=r' $B_{reg} = \bar{B}$')
fill_error(ax, G_scal_Bbarreg*1e+6,G_scal_Bbarreg_err*1e+6, 'r', 0.2)


ax.plot(mrange, G_dat_Bord, c='g', linestyle='dotted', marker='*',mfc='yellow',mec=
ax.plot(kpc_r, G_scal_Bbarord*1e+6, c='green', linestyle='-', marker='o', mfc='k',
              mec='k', markersize=m, label=r' $B_{ord} = \sqrt{\bar{B}^2+b_{ani}^2}
fill_error(ax, G_scal_Bbarord*1e+6,G_scal_Bbarord_err*1e+6, 'g', 0.2)

ax.axhline(y=0, color='black', linestyle='--', alpha = 0.2)

ax.set_xlabel(r'Radius ($kpc$)', fontsize=fs)
ax.xaxis.set_ticks(np.arange(6, 9, 1))
ax.xaxis.set_major_formatter(FormatStrFormatter('%g'))
ax.set_ylabel('Magnetic field strength ($\mu G$)', fontsize=fs)
axis_pars(ax)

G_scal_Bbartot=G_scal_Bbartot*1e+6
G_scal_Bbarreg=G_scal_Bbarreg*1e+6
G_scal_Bbarord=G_scal_Bbarord*1e+6
index_sup = np.where(kpc_r== 8.75)
index_sub = np.where(kpc_r== 14.25)
print('G_scal_Bbartot',G_scal_Bbartot[index_sup],kpc_r[index_sup])
print(G_scal_Bbartot[index_sub],kpc_r[index_sub])
print('G_scal_Bbarreg',G_scal_Bbarreg[index_sup],kpc_r[index_sup])
print(G_scal_Bbarreg[index_sub],kpc_r[index_sub])
print('G_scal_Bbarord',G_scal_Bbarord[index_sup],kpc_r[index_sup])
print(G_scal_Bbarord[index_sub],kpc_r[index_sub])

print('G_scal_Bbartot',G_scal_Bbartot)
print('G_scal_Bbarreg',G_scal_Bbarreg)
print('G_scal_Bbarord',G_scal_Bbarord)

# plt.savefig(r'D:\Documents\Gayathri_college\MSc project\codes\MSc.-Thesis\plots\M
```

```
G_scal_Bbartot [] []
[] []
G_scal_Bbarreg [] []
[] []
G_scal_Bbarord [] []
[] []
G_scal_Bbartot [25.15877611 21.74219034 19.6197876  16.19293729 13.09846359 12.48323
223
 10.5842072   8.88451377  7.66977993  6.2770887   5.64045481  4.47730527
  3.39858022  2.42053761  1.80299001]
G_scal_Bbarreg [1.20860675 1.26008123 1.0425697  1.04214073 1.04273056 0.95216452
 0.85181975 0.7471735  0.68970355 0.62364409 0.58138084 0.55391035
 0.48771192 0.4267541  0.35436528]
G_scal_Bbarord [4.55236162 4.29478841 3.49041627 3.29930641 3.15325533 2.69019005
 2.53994505 2.1447925  1.93033425 1.66880996 1.54667328 1.38615602
 1.13823695 0.91440153 0.71725931]
```

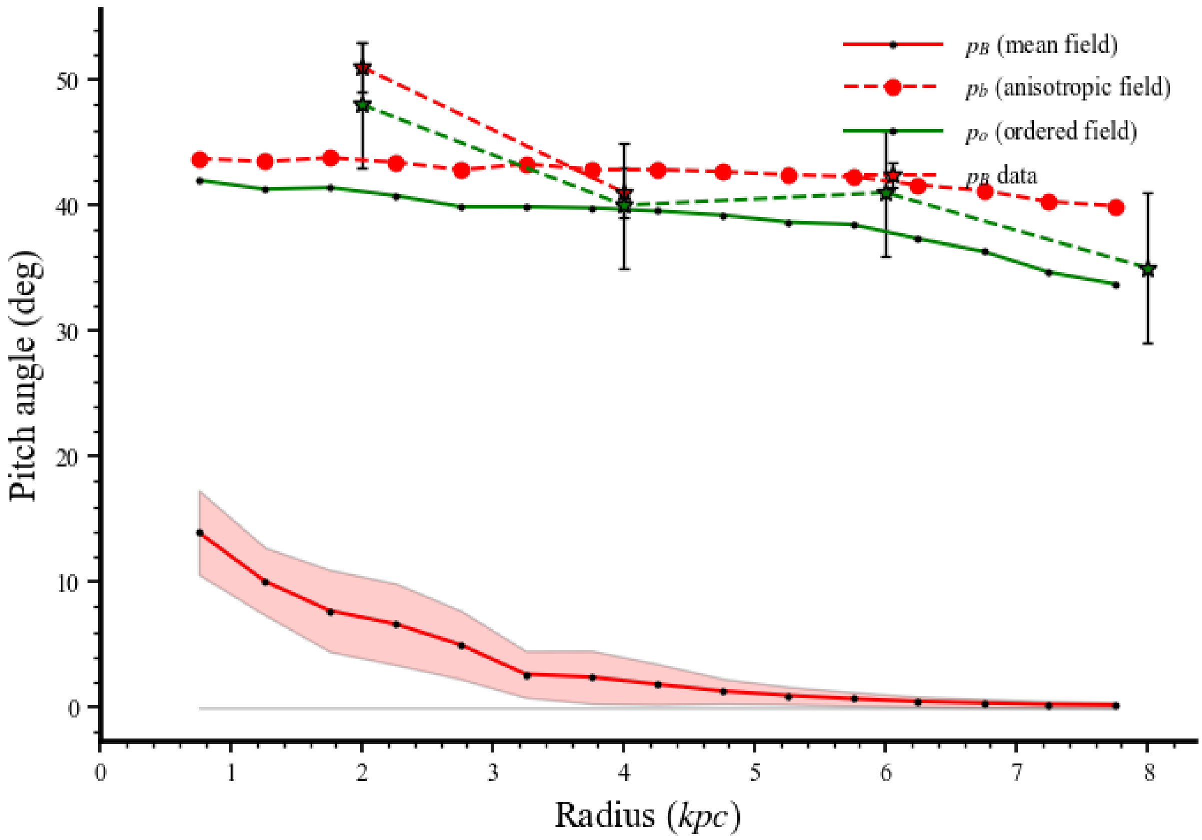


In [ ]:
```
fig,ax = plt.subplots(nrows=1, ncols=1, figsize=(7, 5), tight_layout=True)

####################################     M31     ####################################
# ax.errorbar(mrange, 180*M_dat_pb/np.pi,elinewidth=1, yerr=180*err_M_dat_pb/np.pi,
#                    c='r', linestyle='--', mfc='r', mec='k',label=r' $p_{B}$ data (
# ax.errorbar(rmrange, 180*RM_dat_pb/np.pi,elinewidth=1, yerr=180*err_RM_dat_pb/np.
#                    c='r', linestyle='--', mfc='r', mec='k',label=r' $p_{B}$ data (
# ax.errorbar(rmrange, 180*RM_dat_po/np.pi,elinewidth=1, yerr=180*err_RM_dat_po/np.
#                    c='g', linestyle='--', marker='*', mfc='g', mec='k',ecolor='k')

# ax.plot(kpc_r, 180*pB/np.pi, c='r', linestyle='-', marker='o',
#                markersize=m, mfc='k', mec='k', label=r' $p_{B}$ (mean field)')
# fill_error(ax, 180*pB/np.pi,180*pB_err/np.pi, 'r')
```

```
# ax.plot(kpc_r, 180*pbb/np.pi,c = 'r',linestyle='--', marker='o',label = r' $p_{b}
# ax.plot(kpc_r, 180*pbo/np.pi, c='g', linestyle='-', mfc='k', markersize=m,mec='k'
# fill_error(ax, 180*pog/np.pi,180*pog_err/np.pi, 'g')
###################################     M31     ###################################

###################################     M33     ###################################
ax.errorbar(mrange, 180*M_dat_pb/np.pi,elinewidth=1, yerr=180*err_M_dat_pb/np.pi,ec
                  c='r', linestyle='--', mfc='r', mec='k',label=r' $p_{B}$ data',ba
ax.errorbar(po_mrange, 180*RM_dat_po/np.pi,elinewidth=1, yerr=180*err_RM_dat_po/np.
                  c='g', linestyle='--', marker='*', mfc='g', mec='k',ecolor='k')#,

ax.plot(kpc_r, 180*pB/np.pi, c='r', linestyle='-', marker='o',
              markersize=m, mfc='k', mec='k', label=r' $p_{B}$ (mean field)')
fill_error(ax, 180*pB/np.pi,180*pB_err/np.pi, 'r')
ax.plot(kpc_r, 180*pbb/np.pi,c = 'r',linestyle='--', marker='o',label = r' $p_{b}$
ax.plot(kpc_r, 180*pbo/np.pi, c='g', linestyle='-', mfc='k', markersize=m,mec='k',
fill_error(ax, 180*pog/np.pi,180*pog_err/np.pi, 'g')
###################################     M33     ###################################

###################################     M51     ###################################
# ax.errorbar(mrange, 180*M_dat_pb/np.pi,elinewidth=1, yerr=180*err_M_dat_pb/np.pi,
#                   c='r', linestyle='--', mfc='r', mec='k',label=r' $p_{B}$ data (
# # ax.errorbar(mrange, 180*M_dat_pb/np.pi,elinewidth=1, yerr=180*err_M_dat_pb/np.p
# #                   c='r', linestyle='--', mfc='r', mec='k',barsabove=True,marker
# ax.errorbar(range_po, 180*RM_dat_po/np.pi,elinewidth=1, yerr=180*err_RM_dat_po/np
#                   c='g', linestyle='--', marker='*', mfc='g', mec='k',ecolor='k')
# # ax.errorbar(range_po, 180*RM_dat_po/np.pi,elinewidth=1, yerr=180*err_RM_dat_po/
# #                   c='g', linestyle='--', marker='*', mfc='g',label=r' $p_{o}$ d
# # ax.errorbar(range_po, 180*RM_dat_po/np.pi,elinewidth=1, yerr=180*err_RM_dat_po/
# #                    c='g', linestyle='--', marker='*', mfc='g',label=r' $p_{o}$

# ax.plot(kpc_r, 180*pB/np.pi, c='r', linestyle='-', marker='o',
#               markersize=m, mfc='k', mec='k', label=r' $p_{B}$ (mean field)')
# fill_error(ax, 180*pB/np.pi,180*pB_err/np.pi, 'r')
# ax.plot(kpc_r, 180*pbb/np.pi,c = 'r',linestyle='--', marker='o',label = r' $p_{b}
# ax.plot(kpc_r, 180*pbo/np.pi, c='g', linestyle='-', mfc='k', markersize=m,mec='k'
# fill_error(ax, 180*pog/np.pi,180*pog_err/np.pi, 'g')
###################################     M51     ###################################

###################################     NGC 6946     ###################################
# # ax.errorbar(mrange, 180*M_dat_pb/np.pi,elinewidth=1, yerr=180*err_M_dat_pb/np.p
# #                   c='r', linestyle='--', mfc='r', mec='k',label=r' $p_{B}$ data
# # ax.errorbar(mrange, 180*M_dat_pb/np.pi,elinewidth=1, yerr=180*err_M_dat_pb/np.p
# #                   c='r', linestyle='--', mfc='r', mec='k',barsabove=True,marker

# print('no pB data for 6946 currently')
# ax.errorbar(range1, 180*RM_dat_po_range1/np.pi,elinewidth=1, yerr=180*err_RM_dat_
#                   c='g', linestyle=' ', marker='*', mfc='g',label=r' $p_{o}$ dat
# ax.errorbar(range2, 180*RM_dat_po_range2/np.pi,elinewidth=1, yerr=180*err_RM_dat_
#                   c='g', linestyle=' ', marker='*', mfc='g',label=r' $p_{o}$ dat

# ax.plot(kpc_r, 180*pB/np.pi, c='r', linestyle='-', marker='o',
#               markersize=m, mfc='k', mec='k', label=r' $p_{B}$ (mean field)')
# fill_error(ax, 180*pB/np.pi,180*pB_err/np.pi, 'r')
# ax.plot(kpc_r, 180*pbb/np.pi,c = 'r',linestyle='--', marker='o',label = r' $p_{b}
# ax.plot(kpc_r, 180*pbo/np.pi, c='g', linestyle='-', mfc='k', markersize=m,mec='k'
```

```
# fill_error(ax, 180*pog/np.pi,180*pog_err/np.pi, 'g')
###################################     NGC 6946     ##############################


pB=180*pB/np.pi
pbb=180*pbb/np.pi
po=180*pbo/np.pi
index_sup = np.where(kpc_r== 8.75)
index_sub = np.where(kpc_r== 14.25)
print('pB',pB[index_sup],kpc_r[index_sup])
print(pB[index_sub],kpc_r[index_sub])
print('pbb',pbb[index_sup],kpc_r[index_sup])
print(pbb[index_sub],kpc_r[index_sub])
print('po',po[index_sup],kpc_r[index_sup])
print(po[index_sub],kpc_r[index_sub])

axis_pars(ax)
ax.set_xlabel(r'Radius ($kpc$)', fontsize=fs)
ax.set_ylabel(r'Pitch angle (deg)', fontsize=fs)

# plt.savefig(r'D:\Documents\Gayathri_college\MSc project\codes\MSc.-Thesis\plots\M
print('pB',pB)
print('pbb',pbb)
print('po',po)
```

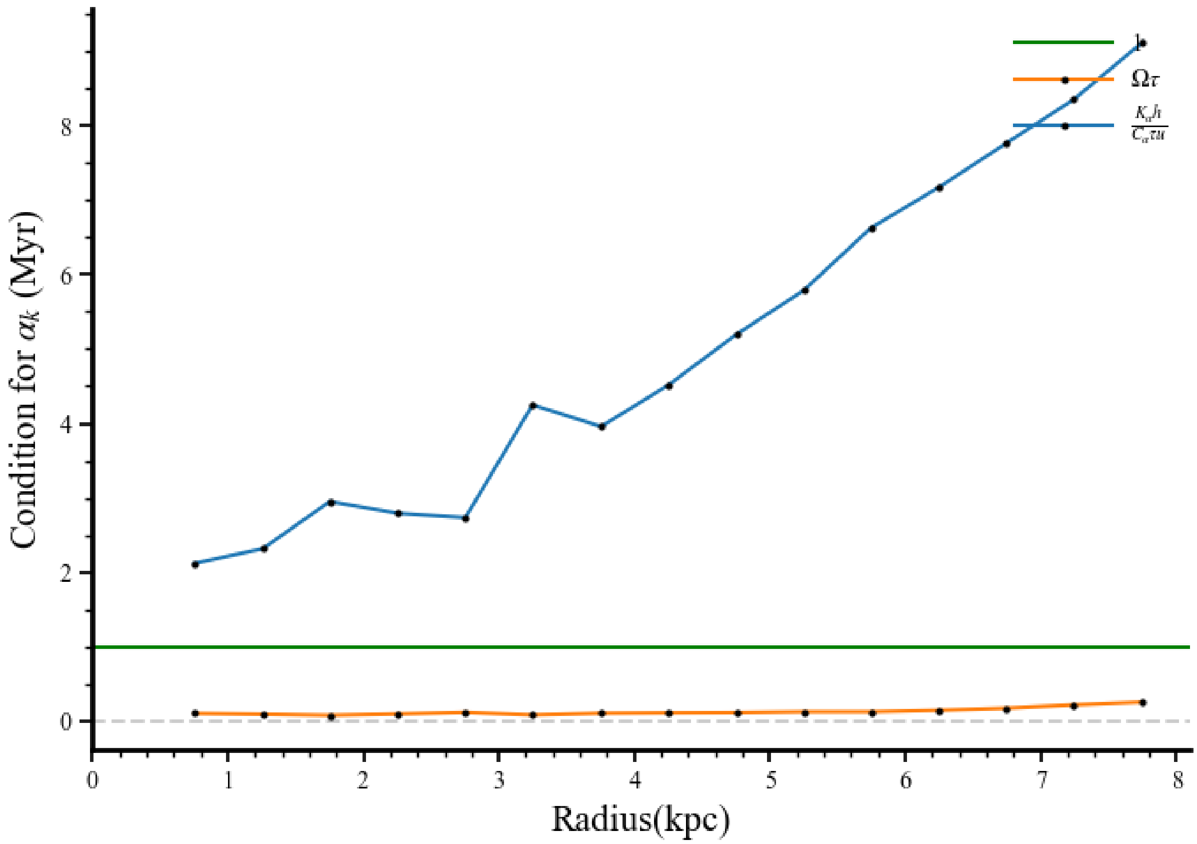
```
pB [] []
[] []
pbb [] []
[] []
po [] []
[] []
pB [13.93338507 10.03387914  7.69582981  6.61653721  4.96979446  2.63244248
  2.39980211  1.84211545  1.28308683  0.93760065  0.67252849  0.45660862
  0.33837753  0.23571316  0.18232497]
pbb [43.70844912 43.48877314 43.77512426 43.41627092 42.82223367 43.27821023
 42.84274958 42.83759437 42.66846112 42.43607211 42.28015822 41.61530364
 41.14999016 40.29794095 39.93970334]
po [41.99043733 41.26568081 41.3996301  40.75043924 39.88461211 39.88080496
 39.77894652 39.53685018 39.20146372 38.66229166 38.4639583  37.34412175
 36.30163088 34.66399715 33.73045486]
```



In [ ]:

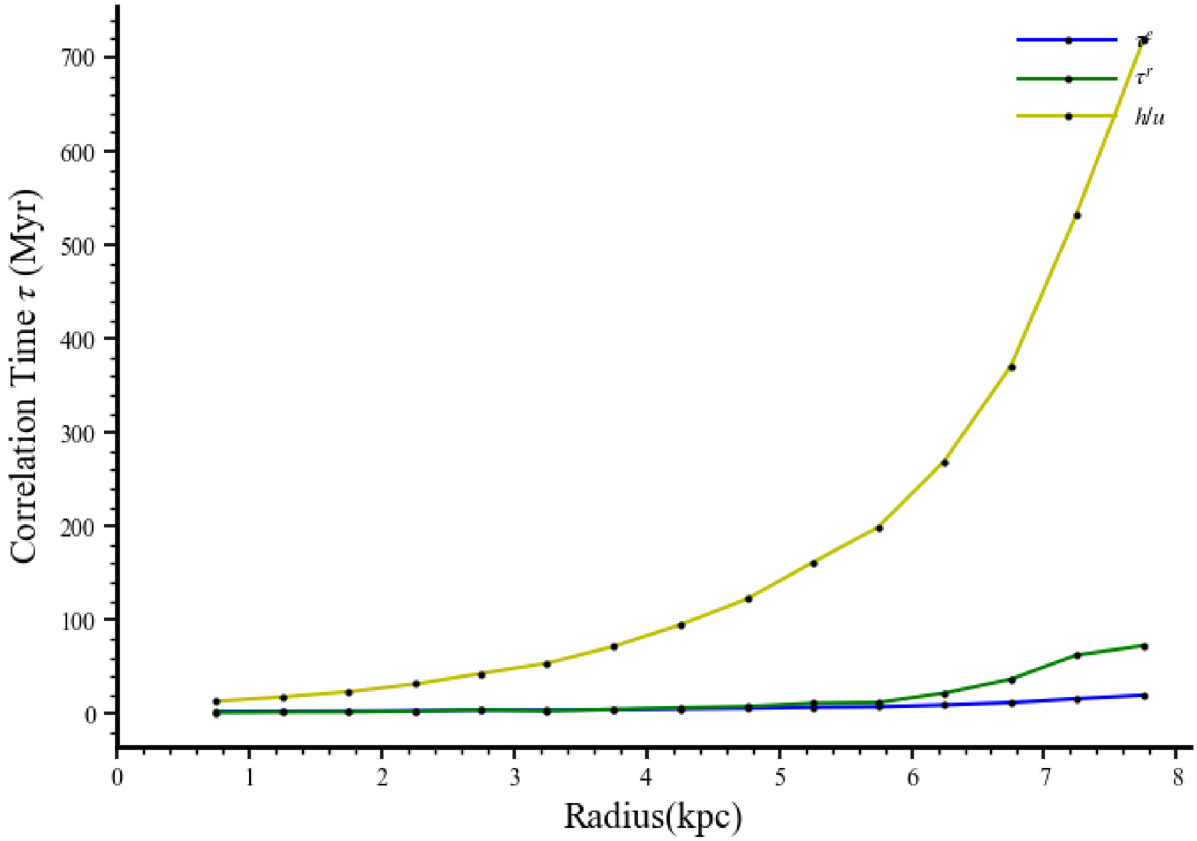
```
fig,ax = plt.subplots(nrows=1, ncols=1, figsize=(7, 5), tight_layout=True)
ax.axhline(y=1, color='g', linestyle='-', label=r'1')
ax.plot(kpc_r, omt, marker='o', markersize=m,
              c='tab:orange', mfc='k', mec='k', label=r'$\Omega\tau$')
ax.plot(kpc_r, kah, marker='o',
              markersize=m, c='tab:blue', mfc='k', mec='k', label=r'$\frac{K_\alpha
ax.axhline(y=0, color='black', linestyle='--', alpha = 0.2)

axis_pars(ax)
ax.set_xlabel('Radius(kpc)', fontsize=fs)
ax.set_ylabel(r'Condition for $\alpha_k$ (Myr)', fontsize=fs)




index_sup = np.where(kpc_r== 8.75)
index_sub = np.where(kpc_r== 14.25)
print('omt',omt[index_sup],kpc_r[index_sup])
print(omt[index_sub],kpc_r[index_sub])
print('kah',kah[index_sup],kpc_r[index_sup])
print(kah[index_sub],kpc_r[index_sub])
# plt.savefig(r'D:\Documents\Gayathri_college\MSc project\codes\MSc.-Thesis\plots\M
```

```
omt [] []
[] []
kah [] []
[] []
```



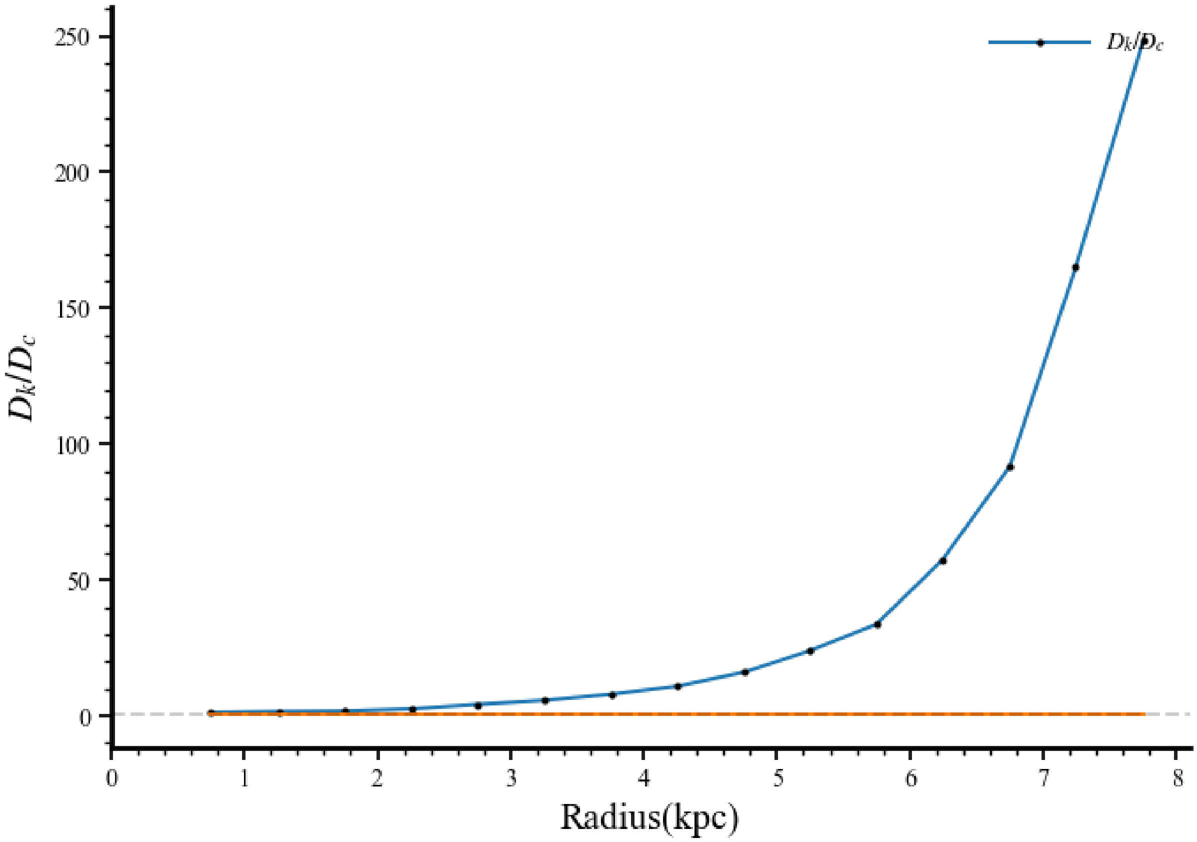
In [ ]:
```
fig,ax = plt.subplots(nrows=1, ncols=1, figsize=(7, 5), tight_layout=True)
ax.plot(kpc_r, taue_f/s_Myr, c='b', markersize=m,
              linestyle='-', marker='o', mfc='k', mec='k', label=r'$\tau^e$')
ax.plot(kpc_r, taur_f/s_Myr, c='g',
              markersize=m, linestyle='-', marker='o', mfc='k', mec='k', label=r'$\
ax.plot(kpc_r, h_f/(u_f*s_Myr), c='y', markersize=m,
              linestyle='-', marker='o', mfc='k', mec='k', label=r'$h/u$')
ax.set_xlabel('Radius(kpc)', fontsize=fs)
ax.set_ylabel(r'Correlation Time $\tau$ (Myr)', fontsize=fs)
axis_pars(ax)


tauef=taue_f/s_Myr
taurf=taur_f/s_Myr
t=h_f/(u_f*s_Myr)
index_sup = np.where(kpc_r== 8.75)
index_sub = np.where(kpc_r== 14.25)
print('tauef',tauef[index_sup],kpc_r[index_sup])
print(tauef[index_sub],kpc_r[index_sub])
print('taurf',taurf[index_sup],kpc_r[index_sup])
print(taurf[index_sub],kpc_r[index_sub])
print('t',t[index_sup],kpc_r[index_sup])
print(t[index_sub],kpc_r[index_sub])


# plt.savefig(r'D:\Documents\Gayathri_college\MSc project\codes\MSc.-Thesis\plots\M
```

```
tauef [] []
[] []
taurf [] []
[] []
t [] []
[] []
```



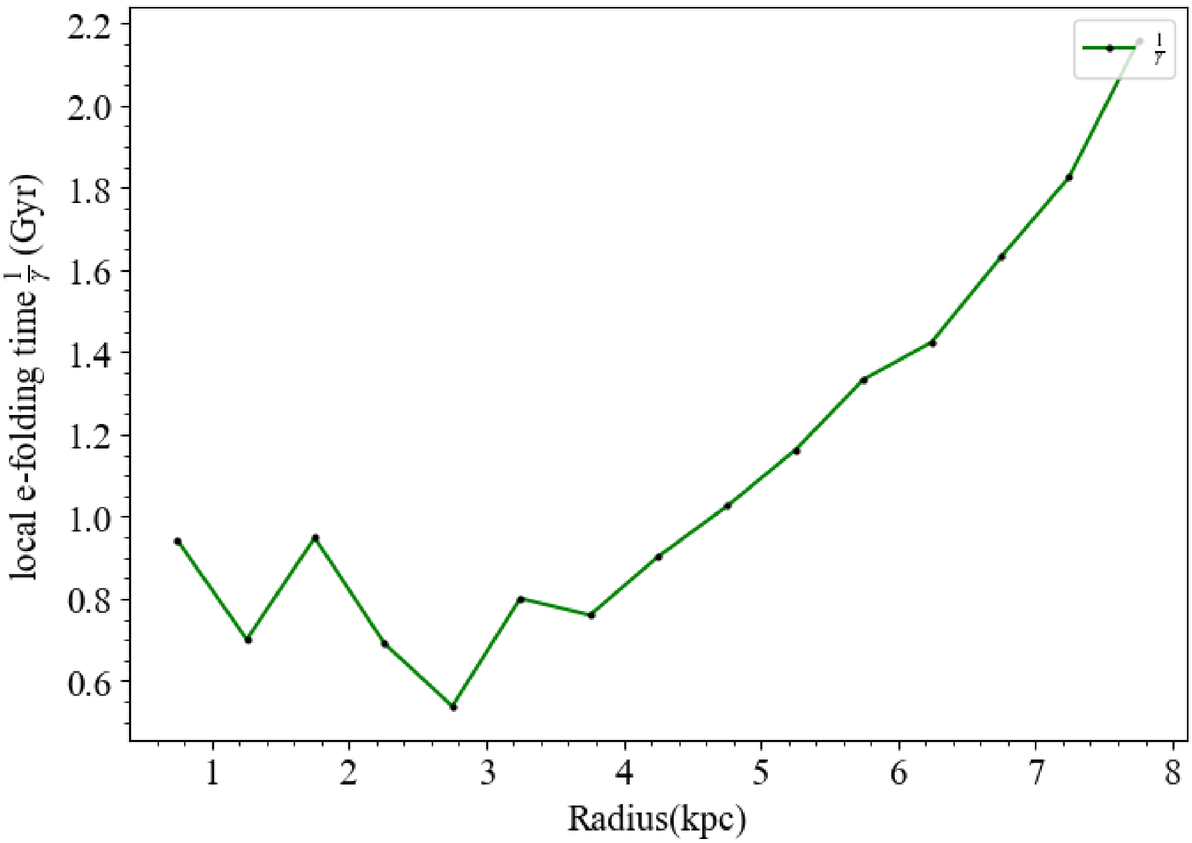
In [ ]:
```
fig,ax = plt.subplots(nrows=1, ncols=1, figsize=(7, 5), tight_layout=True)

ax.plot(kpc_r, dkdc_f, markersize=m, linestyle='-',
              marker='o', mfc='k', mec='k', label=r'$D_k/D_c$')
ax.plot(kpc_r, 1*np.ones(len(kpc_r)))
ax.axhline(y=1, color='black', linestyle='--', alpha = 0.2)

ax.set_xlabel('Radius(kpc)', fontsize=fs)
ax.set_ylabel(r'$D_k/D_c$',  fontsize=fs)
axis_pars(ax)

index_sup = np.where(kpc_r== 8.75)
index_sub = np.where(kpc_r== 14.25)
print('dkdc_f',dkdc_f[index_sup],kpc_r[index_sup])
print(dkdc_f[index_sub],kpc_r[index_sub])
# plt.savefig(r'D:\Documents\Gayathri_college\MSc project\codes\MSc.-Thesis\plots\M
```

```
dkdc_f [] []
[] []
```

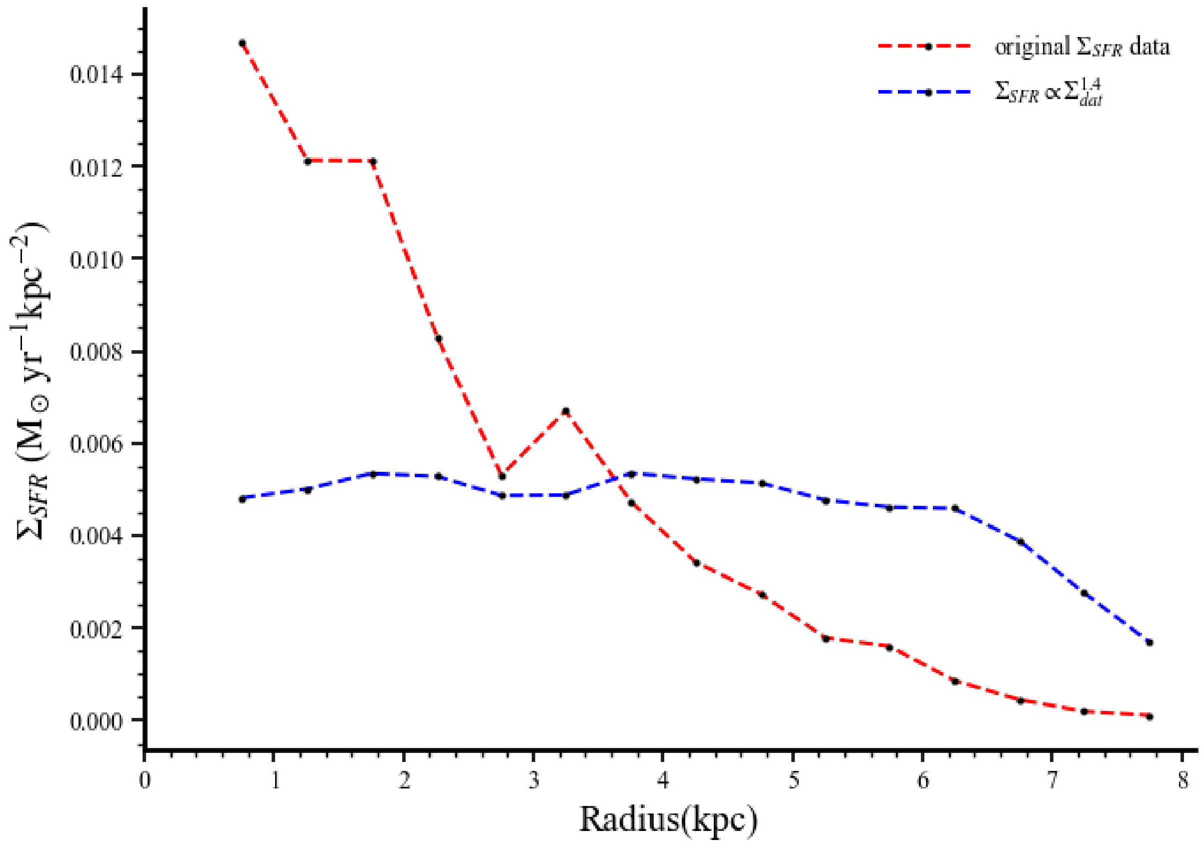


In [ ]:
```
fig,ax = plt.subplots(nrows=1, ncols=1, figsize=(7, 5), tight_layout=True)
ax.plot(kpc_r, (((np.pi**2)*(tau_f*(u_f**2))/3*(np.sqrt(dkdc_f)-1)/(4*h_f**2))**(-1
              (s_Myr*1e+3), c='g', markersize=m, linestyle='-', marker='o', mfc='k'
ax.set_xlabel('Radius(kpc)', fontsize=fs)
ax.set_ylabel(r'local e-folding time $\frac{1}{\gamma}$ (Gyr)', fontsize=fs)
ax.legend(fontsize = lfs)


# plt.savefig(r'D:\Documents\Gayathri_college\MSc project\codes\MSc.-Thesis\plots\M
```

Out[ ]: <matplotlib.legend.Legend at 0x234c5776500>



In [ ]:
```
dat_sigmatot, dat_sigma, dat_sigmasfr, dat_q, dat_omega, zet, T_tb, psi, bet, ca, r
    np.array([data_pass[i][j] for i in range(len(kpc_r))]) for j in range(len(data_
from helper_functions import g_Msun
ks_const = (dat_sigmasfr/(dat_sigma)**(1.4)).mean()
dat_sigmasfr2 = ks_const*(dat_sigma)**(1.4)
dat_sigma3 = ((1/ks_const)*(dat_sigmasfr))**(1/1.4)
fig,ax = plt.subplots(nrows=1, ncols=1, figsize=(7, 5), tight_layout=True)

ax.plot(kpc_r, dat_sigmasfr*(cm_kpc**2)*(s_Myr/1e+6)/g_Msun, c='r',
           linestyle='--', mfc='k', mec='k', markersize=m, marker='o', label=r'orig
ax.plot(kpc_r, dat_sigmasfr2*(cm_kpc**2)*(s_Myr/1e+6)/g_Msun, c='b', linestyle='--'
           mfc='k', mec='k', markersize=m, marker='o', label=r'$\Sigma_{SFR} \propt
# ax.plot(kpc_r, dat_sigma3*(cm_kpc**2)*(s_Myr/1e+6)/g_Msun, c='g', linestyle='--',
#            mfc='k', mec='k', markersize=m, marker='o', label=r'$\Sigma \propto \S
ax.set_xlabel('Radius(kpc)',fontsize=fs)
ax.set_ylabel(r'$\Sigma_{SFR}$ ($\mathrm{M_\odot\,yr^{-1}kpc^{-2}}$)',fontsize=fs)
axis_pars(ax)

# plt.savefig(r'D:\Documents\Gayathri_college\MSc project\codes\MSc.-Thesis\plots\M
```



In [ ]:
```
# os.chdir(current_directory+'\plots')

# #change pdf name here for different galaxies

# from matplotlib.backends.backend_pdf import PdfPages
# PDF = PdfPages('m33_model3_ca_'+str(params[r'C_\alpha'])+'rk_'+str(params[r'R_\ka
#      params[r'\zeta'])+'psi_'+str(params[r'\psi'])+'b_'+str(params[r'\beta'])+'.p
# fig, ax = plt.subplots(nrows=2, ncols=2, figsize=(10, 10), tight_layout=True)
# i = 0
# j = 0
# ax[i][j].plot(kpc_r, h_f*pc_kpc/cm_kpc, c='r', linestyle='-', mfc='k',
#               mec='k', markersize=m, marker='o', label=r' $h$(pc)')
# ax[i][j].plot(kpc_dat_r, pc_dat_h, c='b', linestyle='dotted',
#               marker='*',mfc='y',mec='b',mew=1, markersize = 7, label=r'Fiducial
# ax[i][j].plot(kpc_r, l_f*pc_kpc/cm_kpc, c='g',
#               linestyle='-', mfc='k', mec='k', markersize=m, marker='o', label=r'
# # ax[i][j].plot(kpc_r, datamaker(lsn , data_pass, h_f, tau_f)*pc_kpc/cm_kpc,c = '
# ax[i][j].axhline(y=100, color='black', linestyle='--', alpha = 0.2)
# ax[i][j].set_yticks(list(plt.yticks()[0])+[100])
# axis_pars(ax[i][j])
# fill_error(ax[i][j], h_f*pc_kpc/cm_kpc, h_err*pc_kpc/cm_kpc)
# ax[i][j].set_xlabel(r'Radius (kpc)', fontsize=fs)
# ax[i][j].set_ylabel(r'Length scale (pc)', fontsize=fs)


# i = 0
# j = 1
# ax[i][j].plot(kpc_r, u_f/cm_km, color='tab:orange', marker='o', mfc='k',
#               mec='k', markersize=m, label=r'$u$')
```

```
# fill_error(ax[i][j], u_f/cm_km,u_err/cm_km, 'tab:orange', 0.5)

# ax[i][j].plot(kpc_r, alphak_f/cm_km, color='b', marker='o',
#               mfc='k', mec='k', markersize=m, label=r'$\alpha_k$')
# fill_error(ax[i][j], alphak_f/cm_km,alphak_err/cm_km, 'blue')

# ax[i][j].plot(kpc_r, alpham_f/cm_km, color='r', marker='o',
#               mfc='k', mec='k', markersize=m, label=r'$\alpha_m$')
# ax[i][j].plot(kpc_r, alphasat_f/cm_km, color='m', marker='o',
#               mfc='k', mec='k', markersize=m, label=r'$\alpha_{sat}$')

# sig = np.sqrt(u_f**2 + cs_f**2)
# ax[i][j].plot(kpc_r, sig /
#               cm_km, color='r', marker='o', mfc='k', mec='k', markersize=m, label
# fill_error(ax[i][j], sig /cm_km,np.sqrt((u_f*u_err)**2 + (cs_f*cs_err)**2)/(sig*c

# ax[i][j].plot(kpc_r, cs_f /
#               cm_km, color='g', linestyle='--', label=r'$c_s$', alpha = 0.5)
# fill_error(ax[i][j], cs_f/cm_km,cs_err/cm_km, 'green')

# ax[i][j].plot(kpc_r, dat_u/cm_km,
#               c='y', linestyle='--', label='Without warp',alpha = 1,marker='*',mf
# ,mec='k',mew=1, markersize = 7)
# # ax[i][j].plot(kpc_r, dat_u_warp/cm_km,
# #               c='tab:cyan',  linestyle='dashdot', label='With warp', alpha = 0.
# # ,mec='k',mew=1, markersize = 7)
# axis_pars(ax[i][j])

# ax[i][j].set_ylim(0)
# ax[i][j].set_xlabel(r'Radius ($kpc$)', fontsize=fs)
# ax[i][j].set_ylabel(r'Speed (km/s)',  fontsize=fs)

# i = 1

# #################################################    M31    ######################
# # ax[i][j].errorbar(rmrange, 180*RM_dat_pb/np.pi,elinewidth=1, yerr=180*err_RM_da
# #                   c='r', linestyle='--', mfc='r', mec='k',barsabove=True,marker
# # ax[i][j].errorbar(rmrange, 180*RM_dat_po/np.pi,elinewidth=1, yerr=180*err_RM_da
# #                   c='g', linestyle='--', marker='*', mfc='g', mec='k',ecolor='k
# #################################################    M31    ######################

# #################################################    M33    ######################
# ax[i][j].errorbar(mrange, 180*M_dat_pb/np.pi,elinewidth=1, yerr=180*err_M_dat_pb/
#                   c='r', linestyle='--', mfc='r', mec='k',barsabove=True,marker='
# ax[i][j].errorbar(po_mrange, 180*RM_dat_po/np.pi,elinewidth=1, yerr=180*err_RM_da
#                   c='g', linestyle='--', marker='*', mfc='g', mec='k',ecolor='k')
# #################################################    M33    ######################

# #################################################    6946    #####################
# # ax[i][j].errorbar(range1, 180*RM_dat_po_range1/np.pi,elinewidth=1, yerr=180*err
# #                   c='r', linestyle='--', mfc='r', mec='k',barsabove=True,marker
# # ax[i][j].errorbar(range2, 180*RM_dat_po_range2/np.pi,elinewidth=1, yerr=180*err
# #                   c='g', linestyle='--', marker='*', mfc='g', mec='k',ecolor='k
# #################################################    6946    #####################

# ax[i][j].plot(kpc_r, 180*pB/np.pi, c='r', linestyle='-', marker='o',
```

```
#               markersize=m, mfc='k', mec='k', label=r' $p_{B}$ (mean field)')
# fill_error(ax[i][j], 180*pB/np.pi,180*pB_err/np.pi, 'r')
# ax[i][j].plot(kpc_r, 180*pbb/np.pi,c = 'r',linestyle='--', marker='o',label = r'
# ax[i][j].plot(kpc_r, 180*pog/np.pi, c='g', linestyle='-', mfc='k', markersize=m,

#               mec='k', marker='o', label=r' $p_{o}$ (ordered field)')
# fill_error(ax[i][j], 180*pog/np.pi,180*pog_err/np.pi, 'g')

# axis_pars(ax[i][j])
# ax[i][j].set_xlabel(r'Radius ($kpc$)', fontsize=fs)
# ax[i][j].set_ylabel(r'Pitch angle (deg)', fontsize=fs)

# j= 0
# ax[i][j].plot(mrange, G_dat_Btot, c='b', linestyle='--', marker='*',mfc='yellow',
# ='tab:blue',mew=1,markersize = 7)#, label='Average Binned data $B_{tot}$ ($\mu G$
# ax[i][j].plot(kpc_r, G_scal_Bbartot*1e+6, c='b', linestyle='-', marker='o', mfc='
#               markersize=m, label=r' $B_{tot}=\sqrt{\bar{B}^2+b_{iso}^2+b_{ani}^2
# fill_error(ax[i][j], G_scal_Bbartot*1e+6,G_scal_Bbartot_err*1e+6, 'b')

# ax[i][j].plot(mrange, G_dat_Breg, c='r', linestyle='--', marker='*',mfc='yellow',
# ='tab:red',mew=1,markersize = 7)#, label='Average Binned data $B_{reg}$ ($\mu G$)
# ax[i][j].plot(kpc_r, G_scal_Bbarreg*1e+6, c='r', linestyle='-', marker='o',
#               mfc='k', mec='k', markersize=m, label=r' $B_{reg} = \bar{B}$')
# fill_error(ax[i][j], G_scal_Bbarreg*1e+6,G_scal_Bbarreg_err*1e+6, 'r', 0.2)


# ax[i][j].plot(mrange, G_dat_Bord, c='g', linestyle='dotted', marker='*',mfc='yell
# ,mec='green',mew=1,markersize = 7)#, label='Average Binned data $B_{ord}$ ($\mu G
# ax[i][j].plot(kpc_r, G_scal_Bbarord*1e+6, c='green', linestyle='-', marker='o', m
#               mec='k', markersize=m, label=r' $B_{ord} = \sqrt{\bar{B}^2+b_{ani}^
# fill_error(ax[i][j], G_scal_Bbarord*1e+6,G_scal_Bbarord_err*1e+6, 'g', 0.2)


# ax[i][j].set_xlabel(r'Radius ($kpc$)', fontsize=fs)
# ax[i][j].xaxis.set_ticks(np.arange(1, 7, 2))
# ax[i][j].xaxis.set_major_formatter(FormatStrFormatter('%g'))
# ax[i][j].set_ylabel('Magnetic field strength ($\mu G$)', fontsize=fs)
# axis_pars(ax[i][j])


# PDF.savefig(fig)
# fig, ax = plt.subplots(nrows=2, ncols=2, figsize=(10, 10), tight_layout=True)

# i = 0

# ax[i][j].axhline(y=1, color='g', linestyle='-', label=r'1')
# ax[i][j].plot(kpc_r, omt, marker='o', markersize=m,
#               c='tab:orange', mfc='k', mec='k', label=r'$\Omega\tau$')
# ax[i][j].plot(kpc_r, kah, marker='o',
#               markersize=m, c='tab:blue', mfc='k', mec='k', label=r'$\frac{K_\alp
# axis_pars(ax[i][j])
# ax[i][j].set_xlabel('Radius(kpc)', fontsize=fs)
# ax[i][j].set_ylabel(r'Condition for $\alpha_k$ (Myr)', fontsize=fs)


# j = 1
```

```
# ax[i][j].plot(kpc_r, taue_f/s_Myr, c='b', markersize=m,
#               linestyle='-', marker='o', mfc='k', mec='k', label=r'$\tau^e$')
# ax[i][j].plot(kpc_r, taur_f/s_Myr, c='g',
#               markersize=m, linestyle='-', marker='o', mfc='k', mec='k', label=r'
# ax[i][j].plot(kpc_r, h_f/(u_f*s_Myr), c='y', markersize=m,
#               linestyle='-', marker='o', mfc='k', mec='k', label=r'$h/u$')
# ax[i][j].set_xlabel('Radius(kpc)', fontsize=fs)
# ax[i][j].set_ylabel(r'Correlation Time $\tau$ (Myr)', fontsize=fs)
# axis_pars(ax[i][j])

# i = 1
# ax[i][j].plot(kpc_r, dkdc_f, markersize=m, linestyle='-',
#               marker='o', mfc='k', mec='k', label=r'$D_k/D_c$')
# ax[i][j].plot(kpc_r, 1*np.ones(len(kpc_r)))
# ax[i][j].set_xlabel('Radius(kpc)', fontsize=fs)
# ax[i][j].set_ylabel(r'$D_k/D_c$',  fontsize=fs)
# axis_pars(ax[i][j])

# j = 0
# ax[i][j].plot(kpc_r, (((np.pi**2)*(tau_f*(u_f**2))/3*(np.sqrt(dkdc_f)-1)/(4*h_f**
#               (s_Myr*1e+3), c='g', markersize=m, linestyle='-', marker='o', mfc='
# ax[i][j].set_xlabel('Radius(kpc)', fontsize=fs)
# ax[i][j].set_ylabel(r'local e-folding time $\gamma$ (Gyr)', fontsize=fs)
# ax[i][j].legend(fontsize = lfs)

# PDF.savefig(fig)
# PDF.close()
# os.chdir(current_directory)
```

In [ ]:

```
os.chdir(current_directory)
```