Cosmology: Problem 2

In[1]:=
```
params = {H0 → 0.7*^-10, ΩV → (1 - ΩM)};
ageUniverse = 13.8*^9;
```

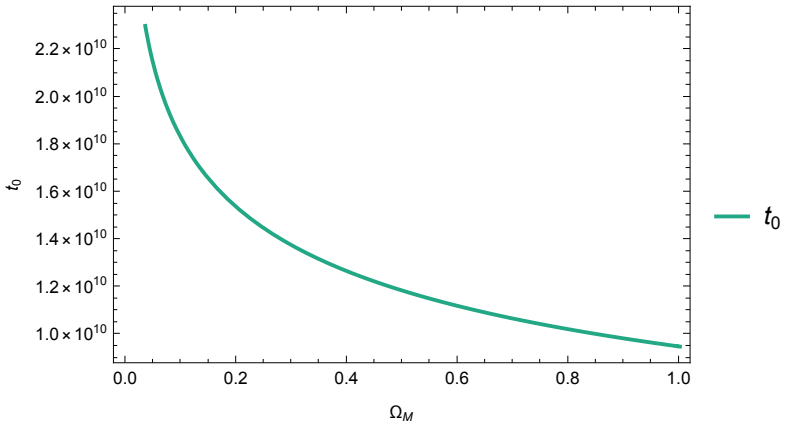
In[3]:=
```
ClearAll [MPLColorMap];
<< "http://pastebin.com/raw/pFsb4ZBS";
viridis = MPLColorMap ["Viridis"][0.6];
viridis1 = MPLColorMap ["Viridis"][0.9];
```

In[7]:=
```
t0 = 1/H0 Integrate[1/(a Sqrt[ΩM/a^3 + ΩV]), {a, 0, 1}, Assumptions → {ΩM > 0, ΩV > 0}]
```

Out[7]=
$$\frac{2\,\text{ArcSinh}\left[\sqrt{\frac{\Omega_V}{\Omega_M}}\right]}{3\,H_0\,\sqrt{\Omega_V}}$$

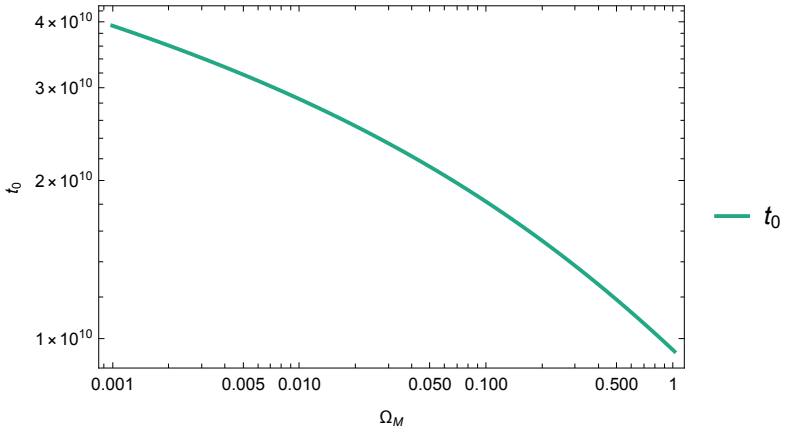
In[8]:=
```
(*Normal Plot*)
fig1 = Plot[t0 /. params, {ΩM, 0, 1}, Frame → True,
  PlotStyle → {viridis, Thick}, FrameLabel → {"ΩM", "t0"}, PlotLegends → {"t0"}]
```

Out[8]=



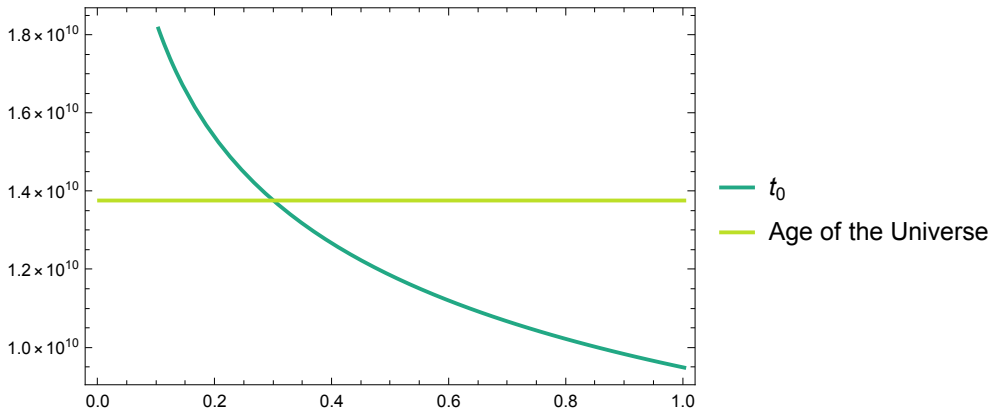
In[9]:=
```
(*Log-Log Plot*)
fig2 = Plot[t0 /. params, {ΩM, 0, 1},
  ScalingFunctions → {"Log", "Log"},
  Frame → True,
  PlotStyle → {viridis, Thick},
  FrameLabel → {"ΩM", "t0"},
  PlotLegends → {"t0"}]
```

Out[9]=



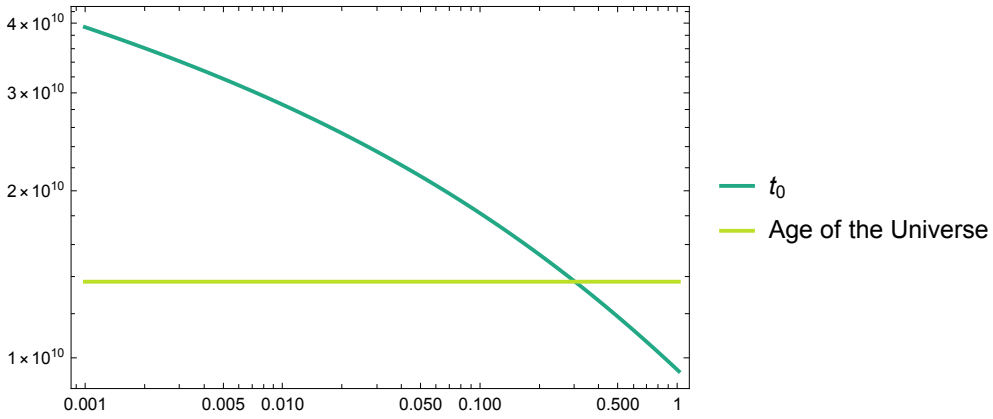
In[10]:=
```
(*Evolution of t0 and the age of the universe*)
fig3 =
 Plot[{t0 /. params, ageUniverse}, {ΩM, 0, 1}, PlotStyle → {viridis, viridis1},
  Frame → True, PlotLegends → {"t0", "Age of the Universe"}]
```

Out[10]=



In[11]:=
```
fig4 = Plot[{t0 /. params, ageUniverse}, {Ω_M, 0, 1},
  PlotStyle → {viridis, viridis1},
  Frame → True,
  ScalingFunctions → {"Log", "Log"},
  PlotLegends → {"t₀", "Age of the Universe"}]
```

Out[11]=



In[12]:=
```
sol = NSolve[(t0 /. params /. Ω_M → x) - ageUniverse == 0, x][[1]]
```

Out[12]=
```
{x → 0.297893}
```