**The Mass Budget of the Coma Cluster of Galaxies**

If we measure the dynamical mass of the Coma Cluster from the velocity dispersion, we get something like

Mgrav ~ 1015 MSun

The Java applet seems to give a value closer to 1014 MSun, so if that is what you get, use your value. The discrepancy seems to be due to the relatively simple dynamical model used to estimate the mass. The total visible luminosity of the Coma cluster galaxies is

Ltot ~ 1012 Lsun

And if we say that each galaxy has a mass-to-light ratio (including both stars and any dark matter within the galaxy) of 10, this says that the galaxies have a total mass of

Mgal ~ 10 x 1012 = 1013Msun

That's just a fraction of the total mass!

But Coma also contains hot gas distributed throughout the cluster which shines not in visible light, but in X-rays. Using X-ray satellites, we can observe and estimate the mass of this gas; it turns out to be about

Mx ~ 1014 Msun

X-ray observations of the Coma Cluster of Galaxies indicate that the space within the cluster contains not only galaxies, but hot gas that emits X-rays and can be detected with X-ray telescopes. Coma contains six times more mass in hot gas disbursed throughout the cluster than is in the visible galaxies. But even with the hot gas, the visible mass (hot gas plus galaxies) is still much less than the gravitational mass of the cluster measured using the velocity dispersion of the galaxies.

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| **Coma Mass Budget** |
| Dynamical Mass (astronomer’s value) | 1015 solar masses |
| Dynamical Mass (your value) |  |
| Mass from Luminosity | 1012 solar masses |
| Galaxy Mass with Dark Matter | 1013 solar masses |
| Hot Gas from X-ray Luminosity | 1014 solar masses |
| Fraction of mass that is baryonic (not DM) |  |

Based on arguments like this, astronomers have been led to the conclusion that most of the mass in galaxy clusters -- and in the universe in general -- remains unobserved, the strange "dark matter" that we still don't understand...