

Dating the Universe

Welcome to the biggest dating show of all time! In this episode, you're the fortunate bachelorette, and have been given the chance to date the universe of your dreams! They all have the same Hubble constant – 71 km/s/Mpc. But that's where the similarities end!

Directions: Use the verbal descriptions provided to "fill in" the parameters below with whatever you can say about them (This may be a precise value, a range, or you may be unable to constrain it.) As a recap, the parameters are –

Ω_m : Matter density. The amount of matter in the universe compared with the amount needed to stop its expansion (assuming no antigravity). A universe with exactly enough matter to halt this expansion has $\Omega_m = 1$.

Ω_Λ : Antigravity density. The amount of antigravitational dark energy in the universe, measured in the same units as Ω_m .

t_0 : Age. The age, or age range, of the universe.

Geometry: Spherical, flat, or hyperbolic? Depends on $\Omega_m + \Omega_\Lambda$: if this sum is greater than one, it is spherical; less than one, hyperbolic; equal to one, flat.

Ultimate fate: How will this universe end?

Finally, plot the separation of our galaxy from some other galaxy with time on the right side of the paper.

Let's meet our lucky contestants...

The Empty Universe

He's a little bit empty-headed, but we assure you he's quite stable.

This universe has no matter within it but is expanding anyway.

Ω_m :

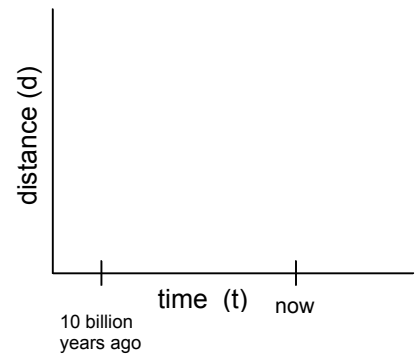
Ω_Λ :

$\Omega_m + \Omega_\Lambda$:

Geometry:

Ultimate fate:

Age:



The Coasting Universe

Kind of a lightweight.

This universe has a small amount of matter in it – enough to slow things down a bit early on, but after a certain point galaxies become too far apart and they just keep drifting at a constant speed. This was considered to be the most likely candidate for our universe before 1998.

Ω_m :

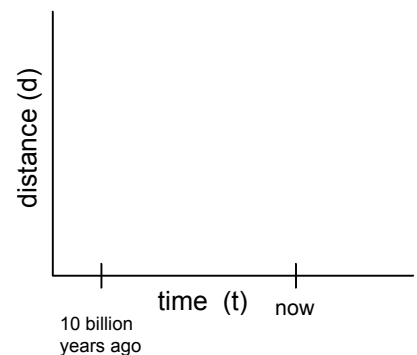
Ω_Λ :

$\Omega_m + \Omega_\Lambda$:

Geometry:

Ultimate fate:

Age:



The Critical Universe

This guy's always on the edge!

This universe has exactly the amount of matter required to slow its expansion to a stop – but it will take an infinite amount of time to reach that point. The theoretically simplest universe.

Ω_m :

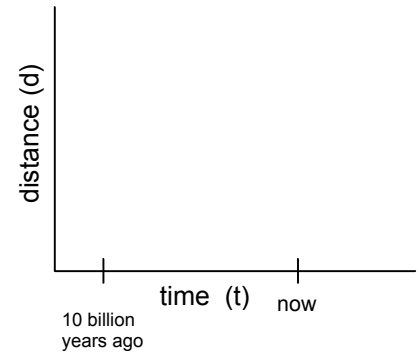
Ω_Λ :

$\Omega_m + \Omega_\Lambda$:

Geometry:

Ultimate fate:

Age:



The Collapsing Universe

What can we say... he's kind of dense. But hurry, he won't last long!

The collapsing universe has matter density in excess – perhaps significantly in excess – of that which is required for gravity to cause the expansion to stop. Once the expansion stops, gravity continues, and the universe begins to collapse in upon itself. Hasn't been considered as a serious possibility since the 1930's.

Ω_m :

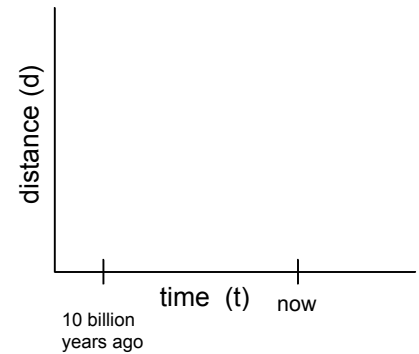
Ω_Λ :

$\Omega_m + \Omega_\Lambda$:

Geometry:

Ultimate fate:

Age:



The Accelerating Universe

Age gracefully? He may be old, but he's only just getting started!

The accelerating universe starts like any other one, and may even decelerate for a time under gravity. But in this universe, space itself is endowed with a repulsive property that causes the universe to expand faster as it gets larger – and this quickly overwhelms gravity and makes the universe expand faster, faster, and faster forever.

Ω_m :

Ω_Λ :

$\Omega_m + \Omega_\Lambda$:

Geometry:

Ultimate fate:

Age:

