

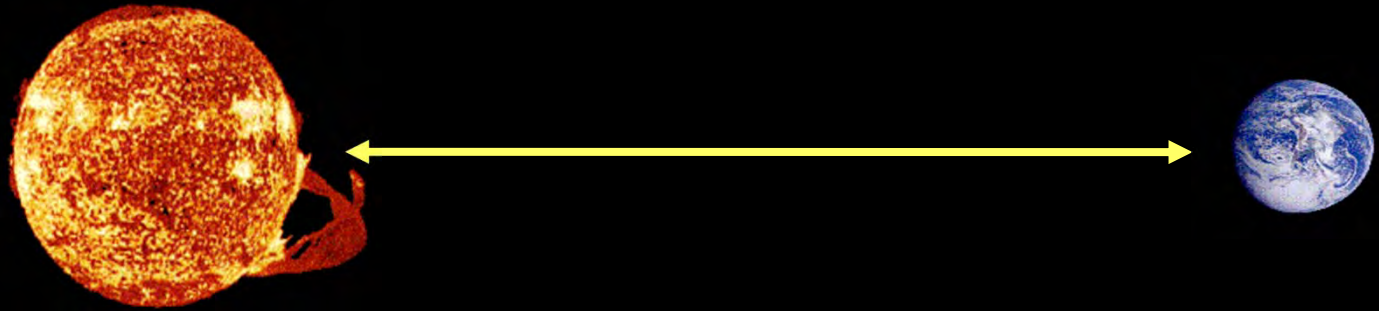
THE UNIVERSE IS

BIG!

Light travels 300,000 km per sec
that is 7.5 times around the Earth
each second.

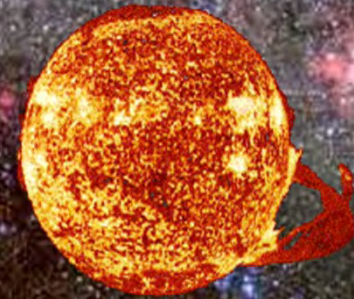
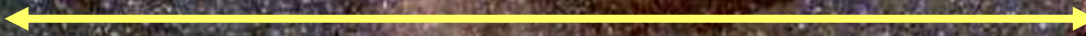


8 light minutes



4.3 light years

⟨ □ Centauri



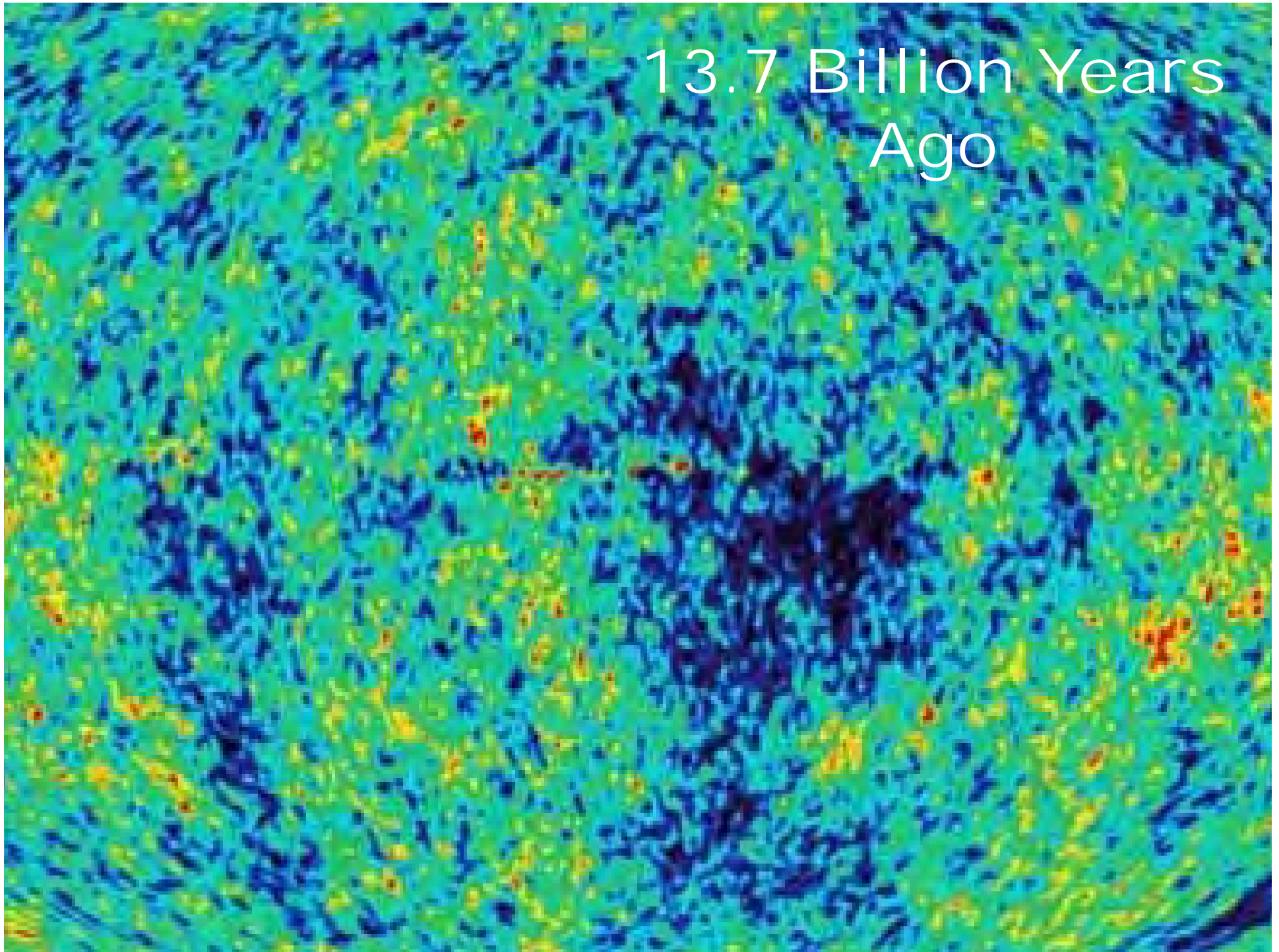
30,000 light years



12 Billion Years

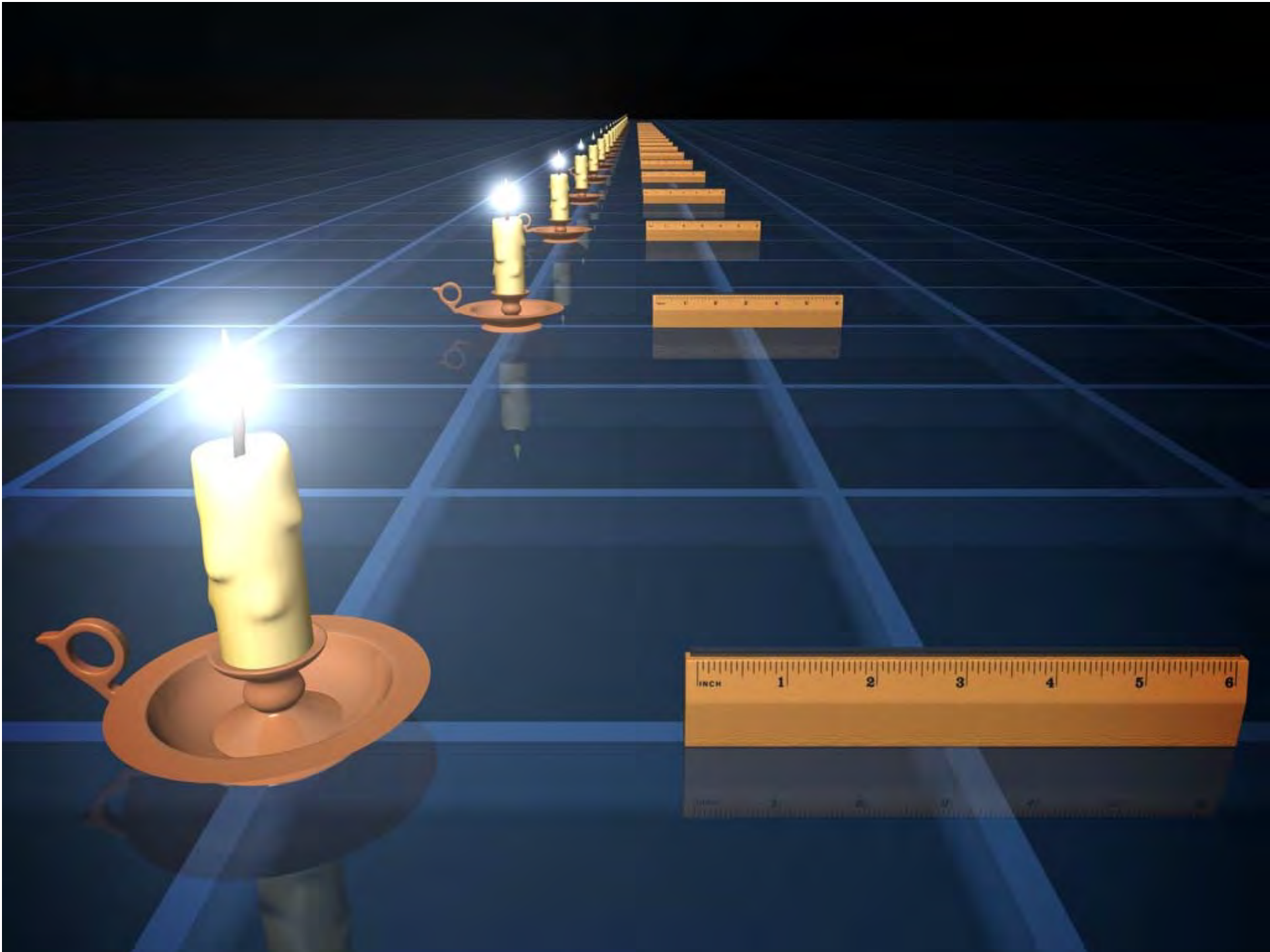


13.7 Billion Years
Ago

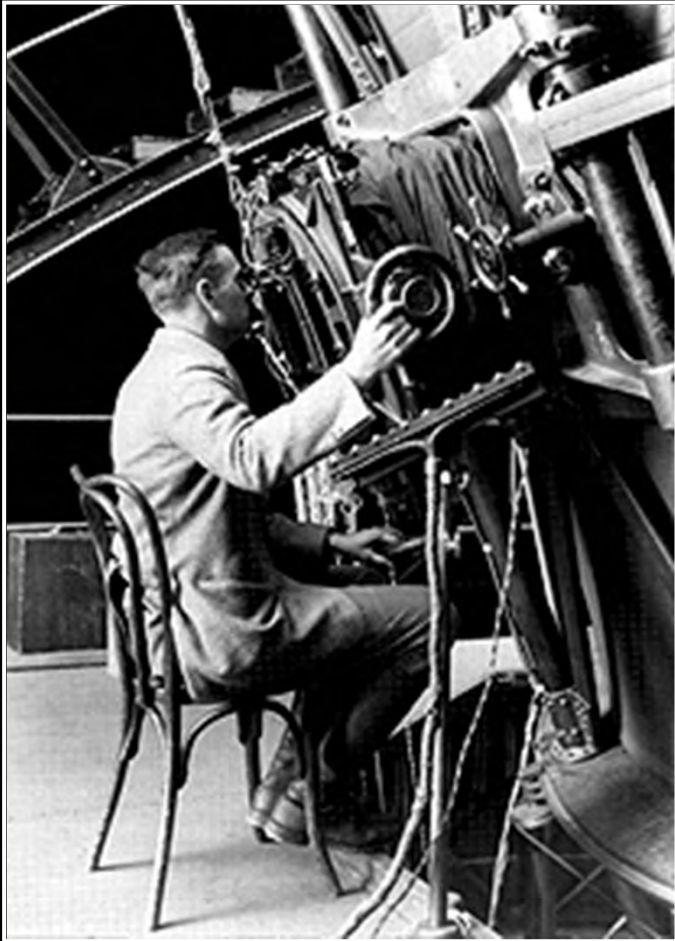


The

Big Bang



*1929, Hubble uses brightest stars
to measure the
distances to the
nearest galaxies.*



*He assumes the
brightest stars are
all the same
brightness.*

**The faster the galaxy was moving,
the fainter the stars!**

**The
Universe is
Expanding**



Hubble's Law

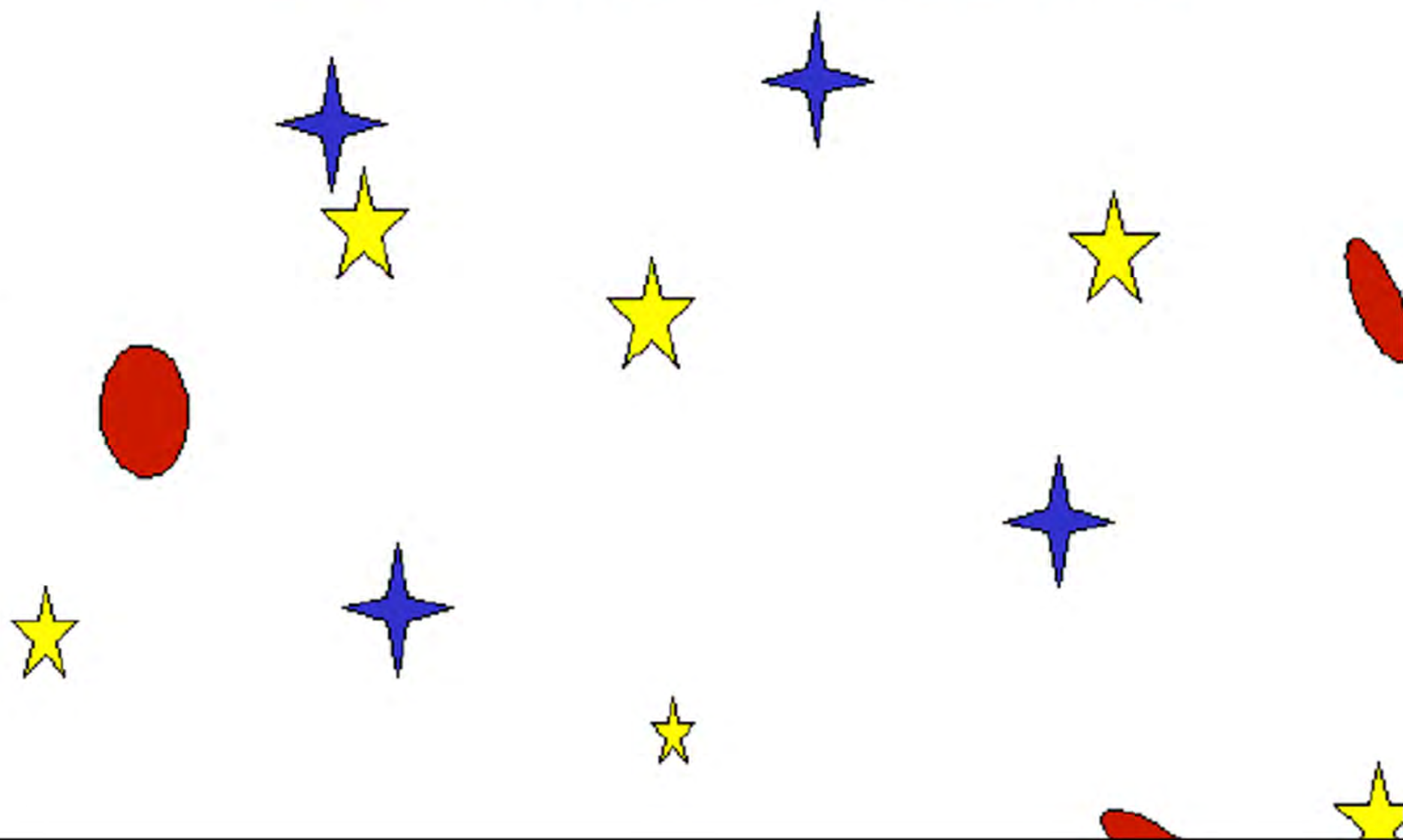




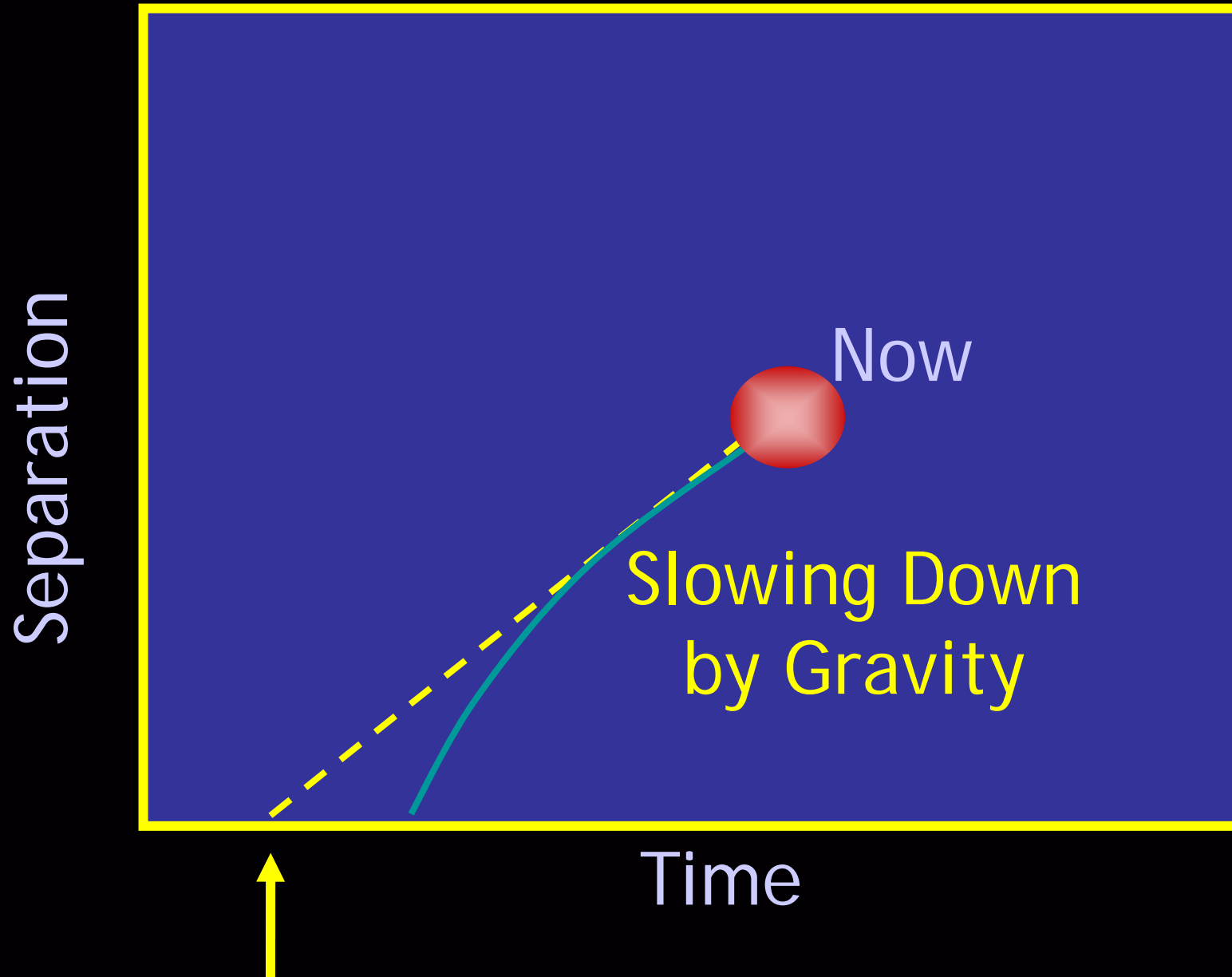


YOU
ARE
HERE

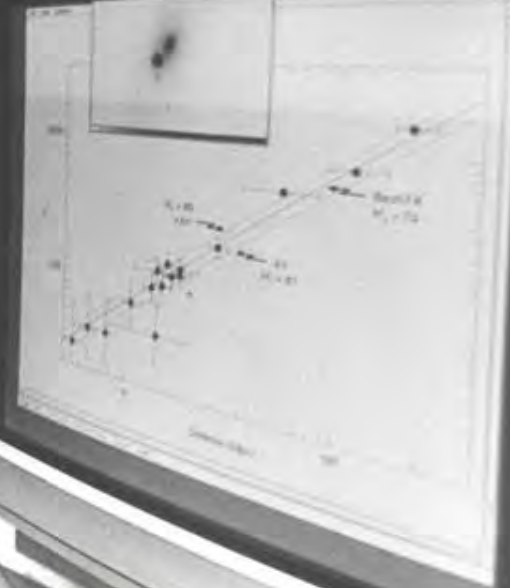
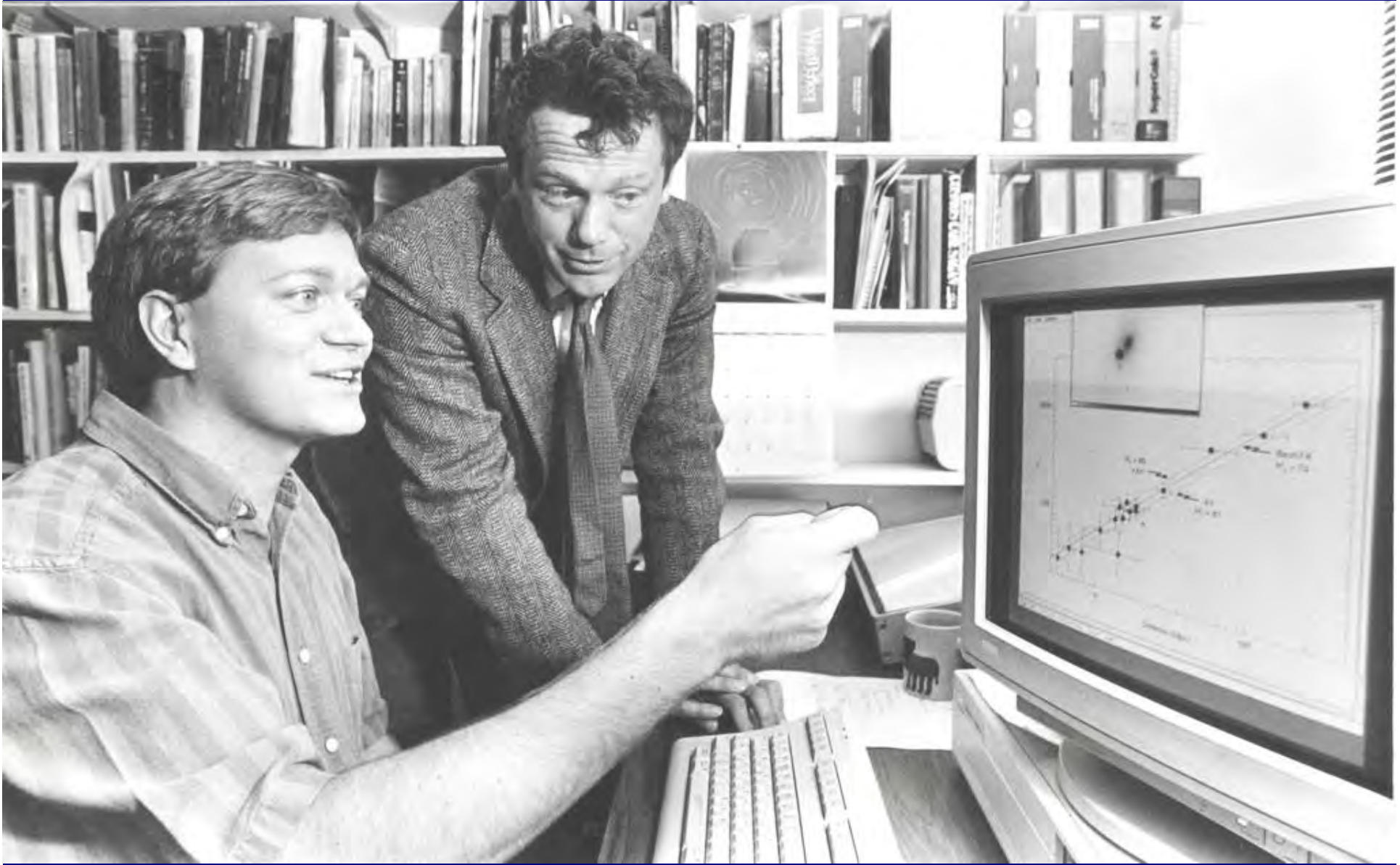
To the Future



The Distance Between Two Galaxies





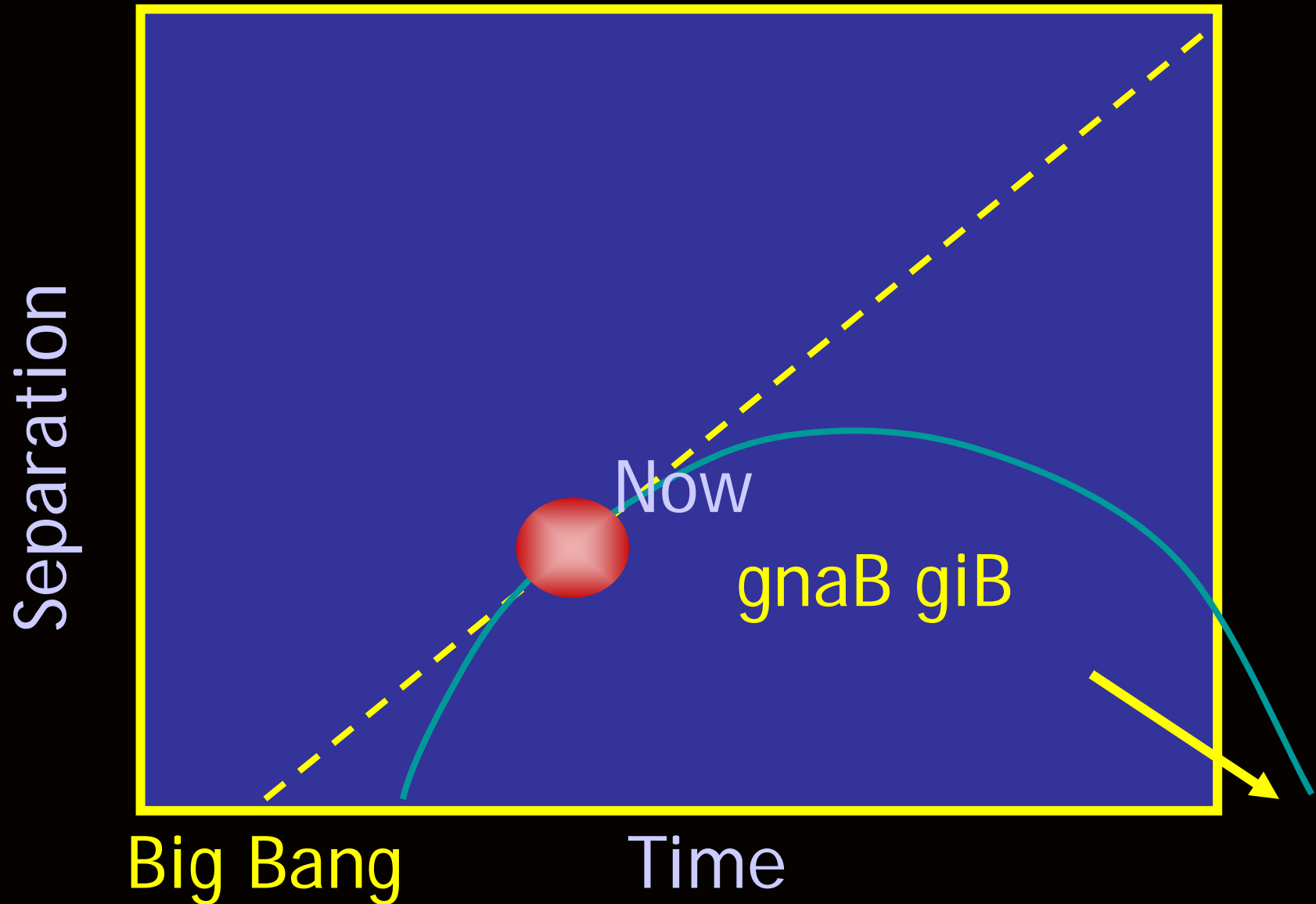


The Hubble Constant Tells us the age of the Universe...

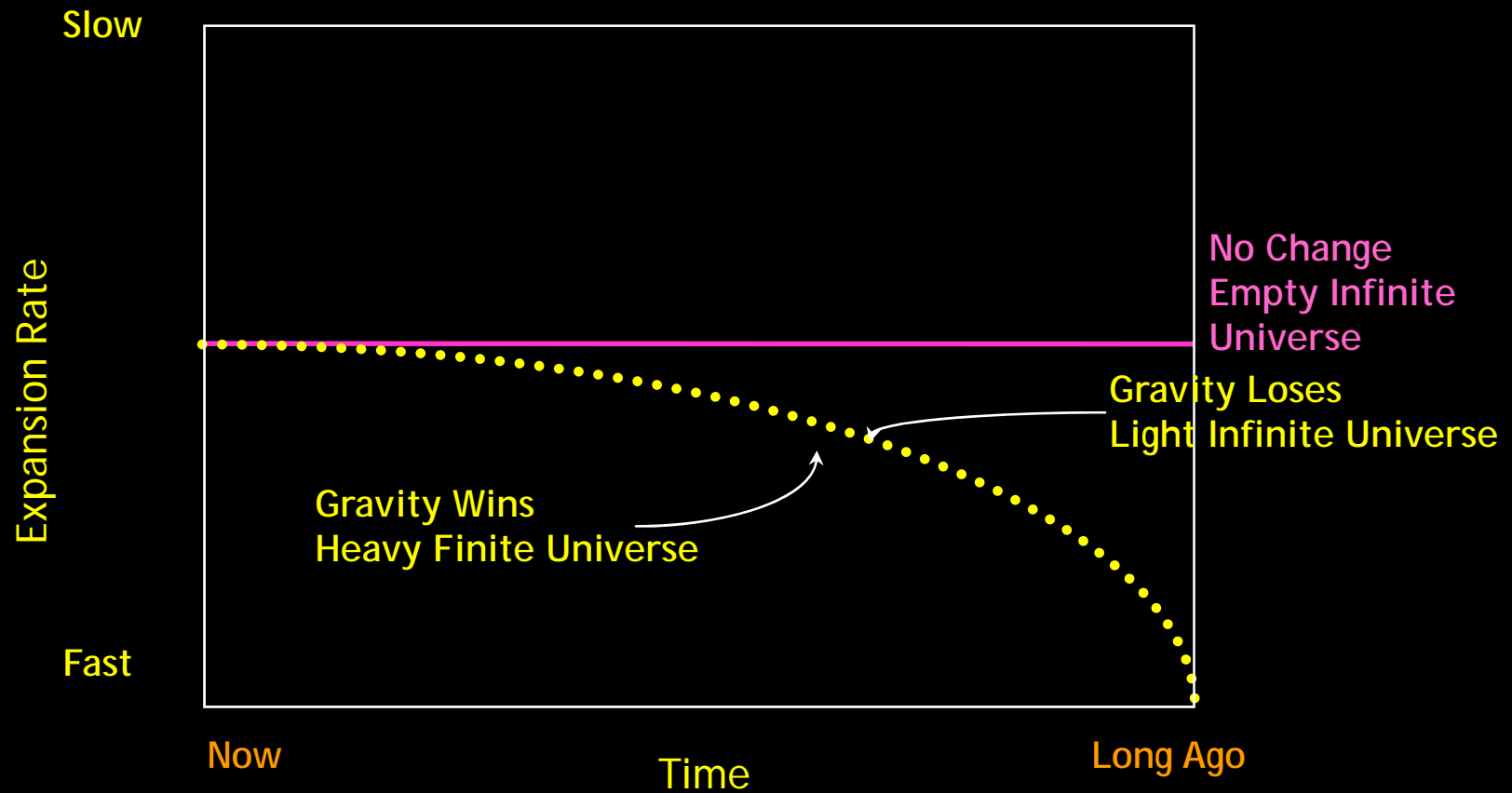
$H_0=50$	$t=19.6$ Billion Years
$H_0=60$	$t=16.3$ Billion Years
$H_0=70$	$t=14.0$ Billion Years
$H_0=80$	$t=12.3$ Billion Years
$H_0=90$	$t=10.9$ Billion Years
$H_0=100$	$t= 9.8$ Billion Years



Looking towards the Future



Measure Universe's Past



Type Ia Supernovae



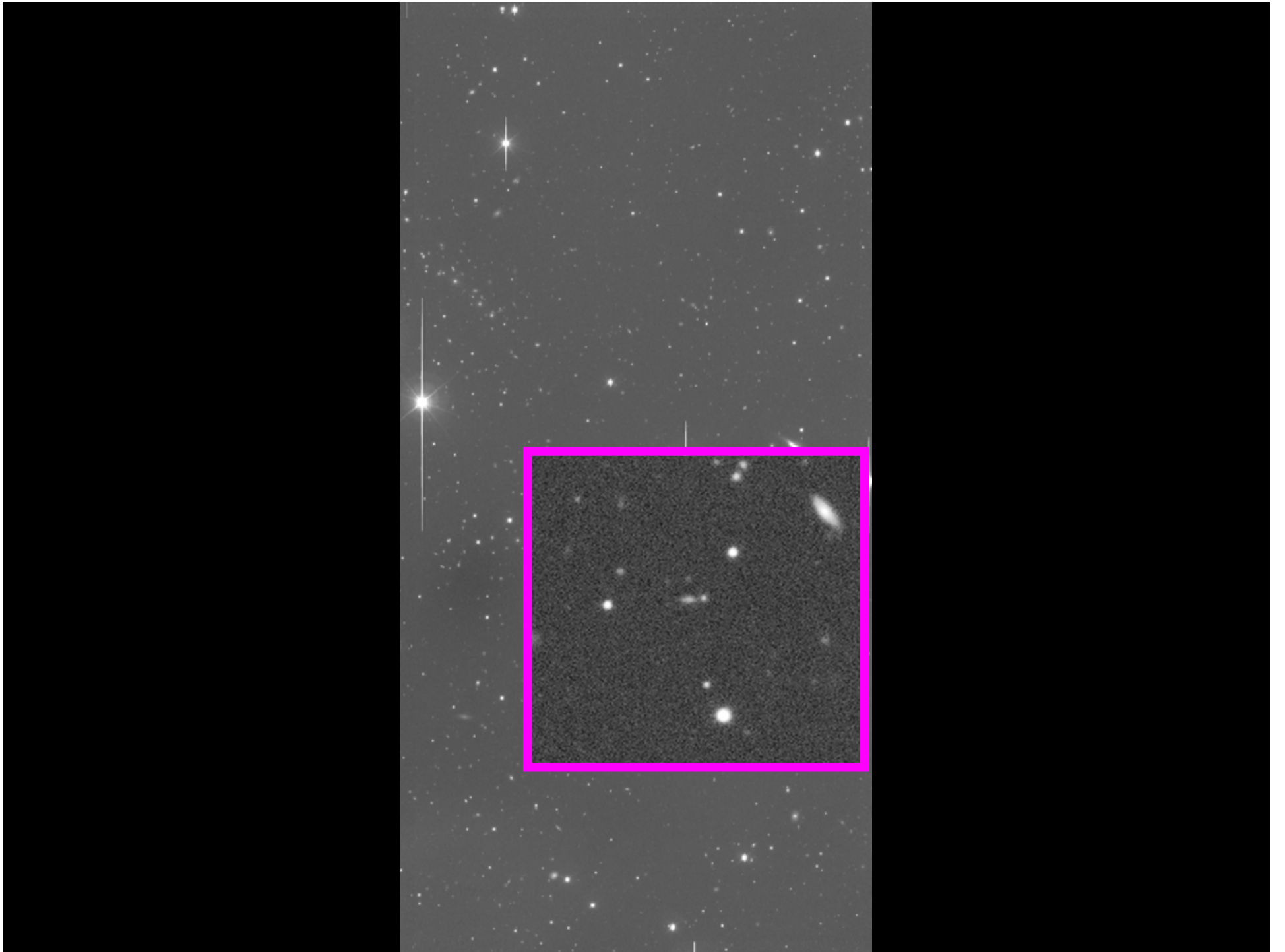
Sun Earth (10 billion years)



Type Ia Supernova

0 days

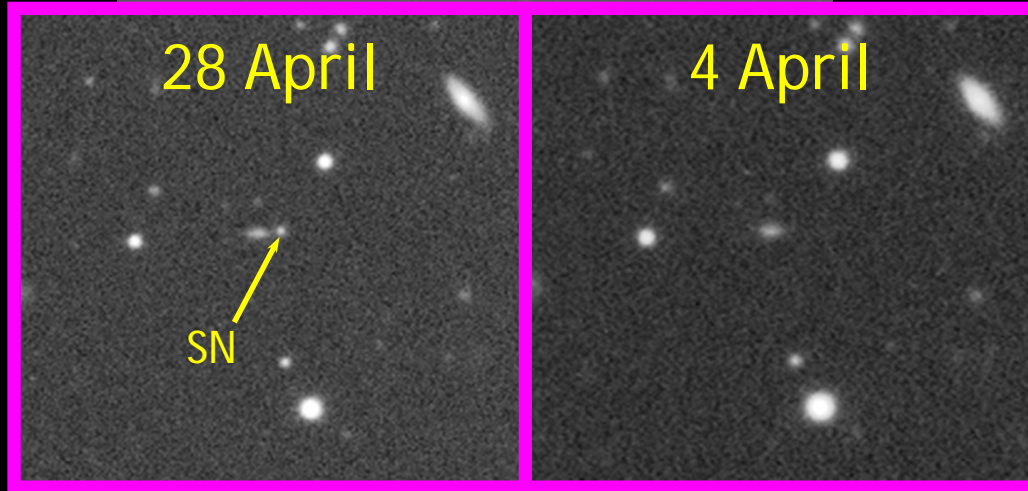




28 April

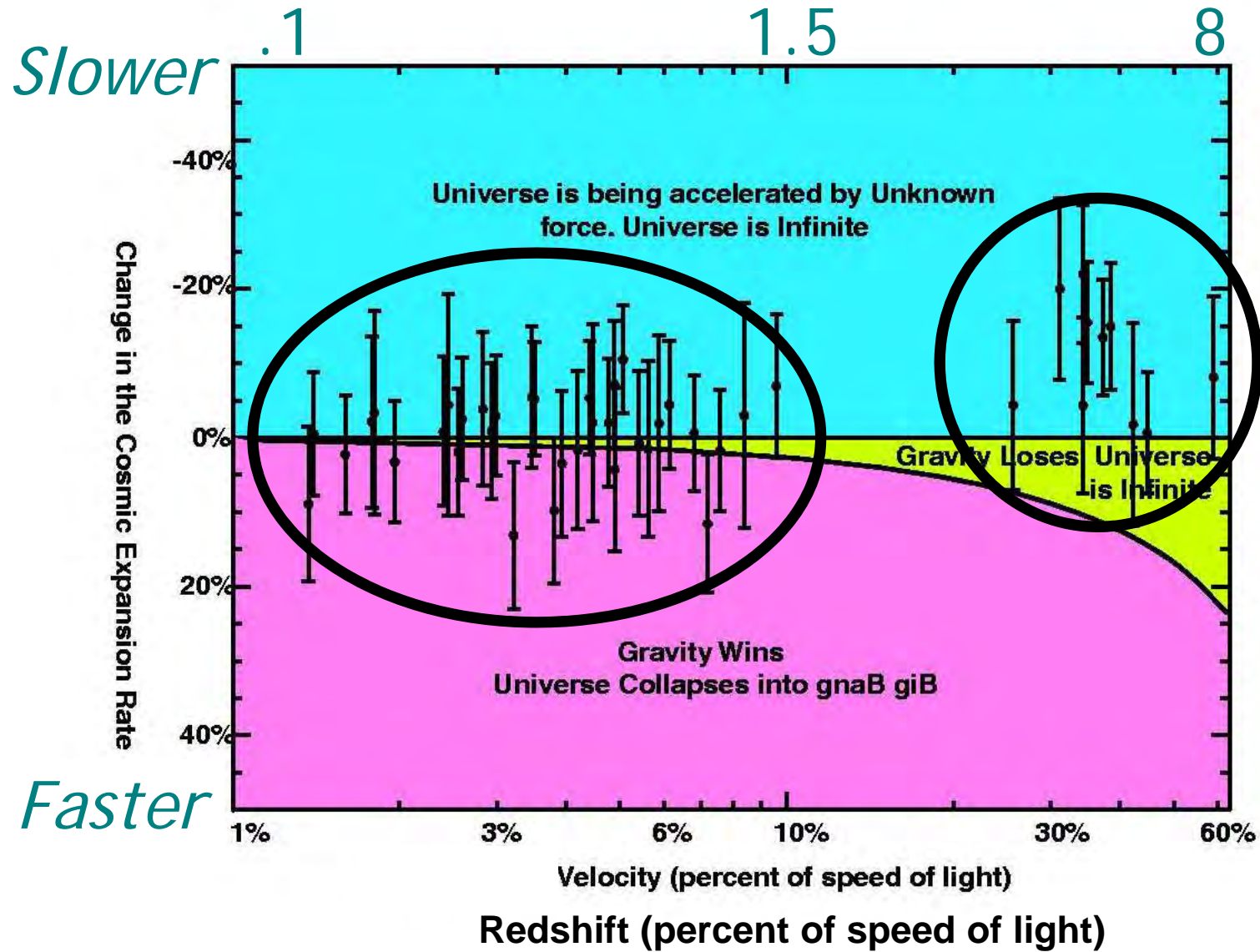
SN

4 April





Time (Billions of Years)





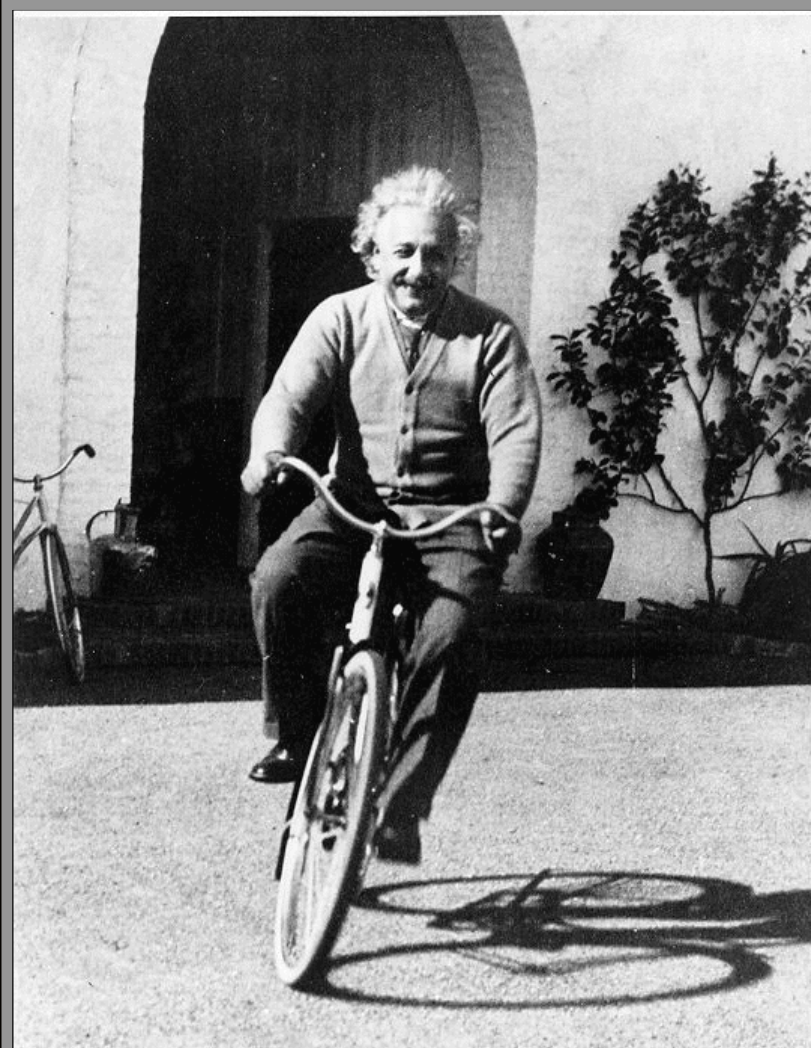






**What is Pushing
on the
Universe?**

Dark Energy



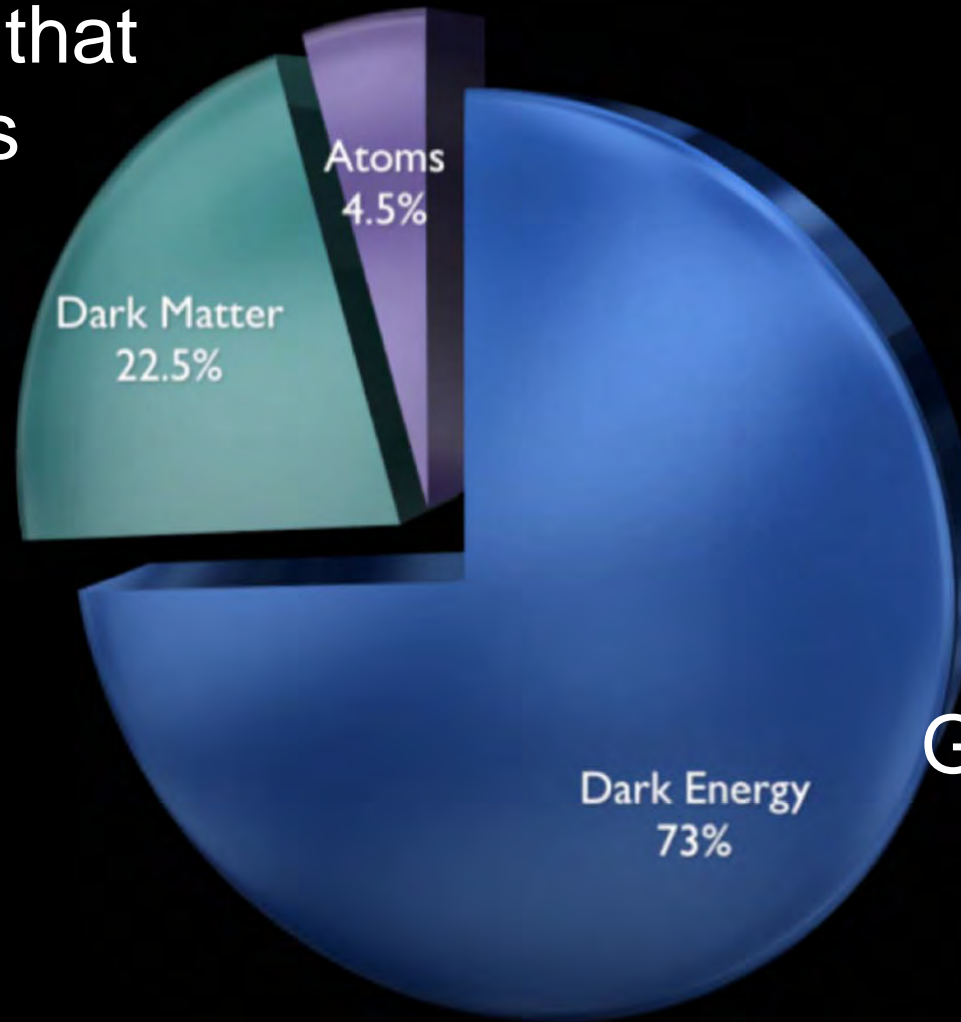
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The Cosmological Constant

Energy as part of Space

In Einstein theory of General Relativity, this material causes Gravity to push rather than pull

Gravity that
Pulls



Gravity that
Pushes

The Messy Universe

The Future of the Universe

The Future of the Universe seems to be Dark Energy

The More Space Expands - the More Dark Energy can push against gravity - Creating even more space and more Dark Energy

The creation of space happens more quickly than even light can travel!



- unless Dark Energy suddenly
Disappears -

The Universe will
at an ever increasing rate
expand and fade away...