Big Rip

Universe is expanding
(from Hubble Law)
distance out to $z < 0.2$

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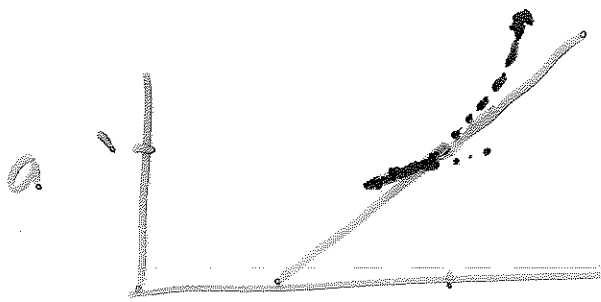
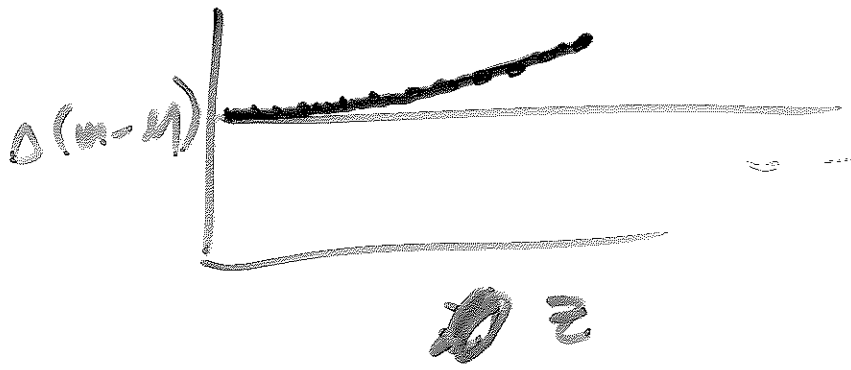
acceleration vs. deceleration
↓ ↓
Dark Energy vs. matter (Dark Matter)

SNe $z > 0.3$ (out to about $z = 1$)

IN PAST: Universe was expanding more slowly than now

∴ Universe is accelerating
∴ Dark Energy > matter





Dark energy vs. Dark Matter

current DE > DM

this change with time

matter density in past

same amount of matter

Universe was smaller

$\rho = \frac{M}{V}$ ⇒ bigger in past

Λ is constant!

density is constant

in the past D.E. density

was SAME as now

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if matter gets bigger in past

and pos dog not

be at some point in past

$DE = DM$

before that DM wins

→ Universe decelerating

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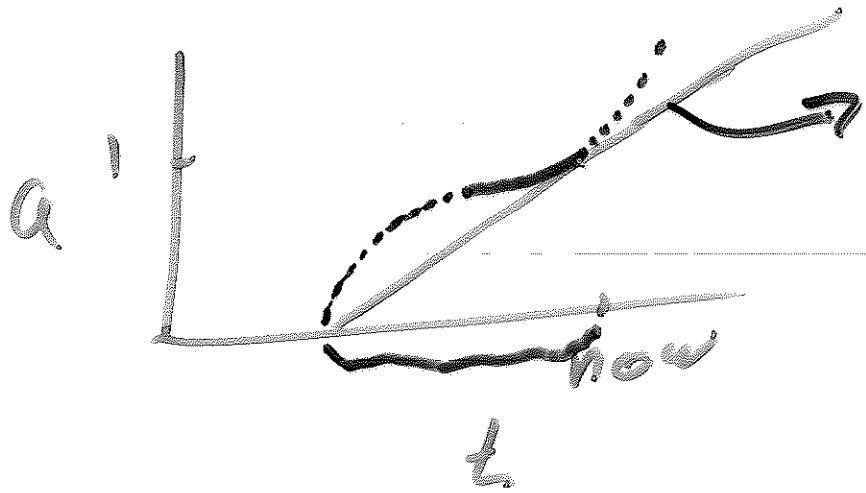
from start until some moment

Universe decelerates

after some moment

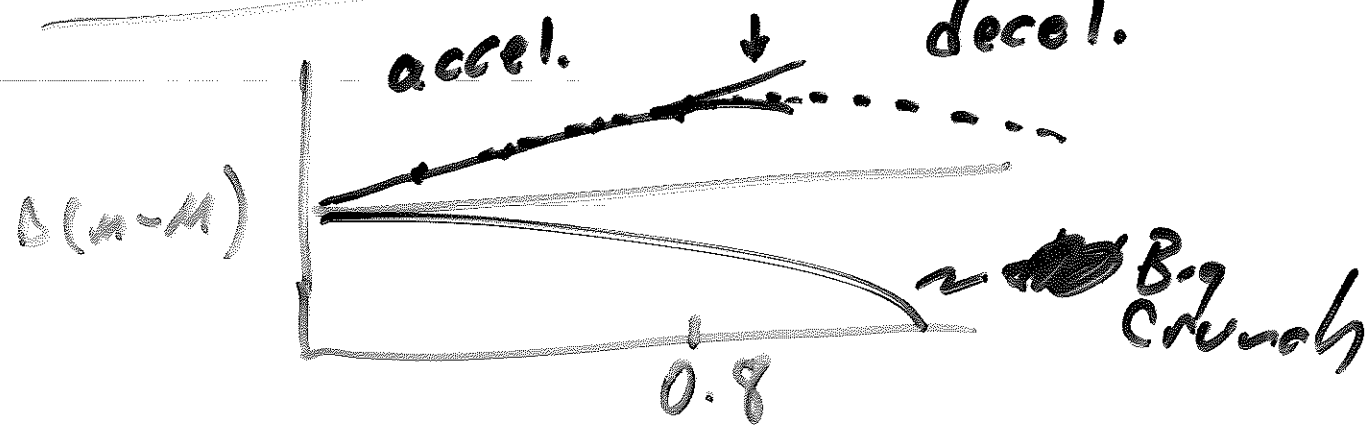
accelerates



$\Omega_m = .25$
$\Omega_\Lambda = .75$
(at present)
and
$H_0 = 70$

$\Omega < 1$ => decel
$\Omega > 1$ => accel

age of universe
13.4 billion yrs



hard to see SN $z > 1$

1) faint
2) on top of galaxies
   → look smaller
3) light is redshifted
   most radiation is in infrared

DO THIS FROM SPACE

2) much better images
3) IR background is MUCH fainter
   and no atmospheric absorptions

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recently: Using HST to find high-z supernovae
Small field of view → don't find many SN

See Kinematic SN Ia residual Hubble Diagram, Fig. 6 in Riess et al. *Astrophysical Journal*. 2004. pp 607, 665

a reason to worry...

gravitational lensing
makes things look brighter

a) more distant objects
more likely to be lensed

b) at fixed z you see
~~about~~ abnormally bright
things preferentially

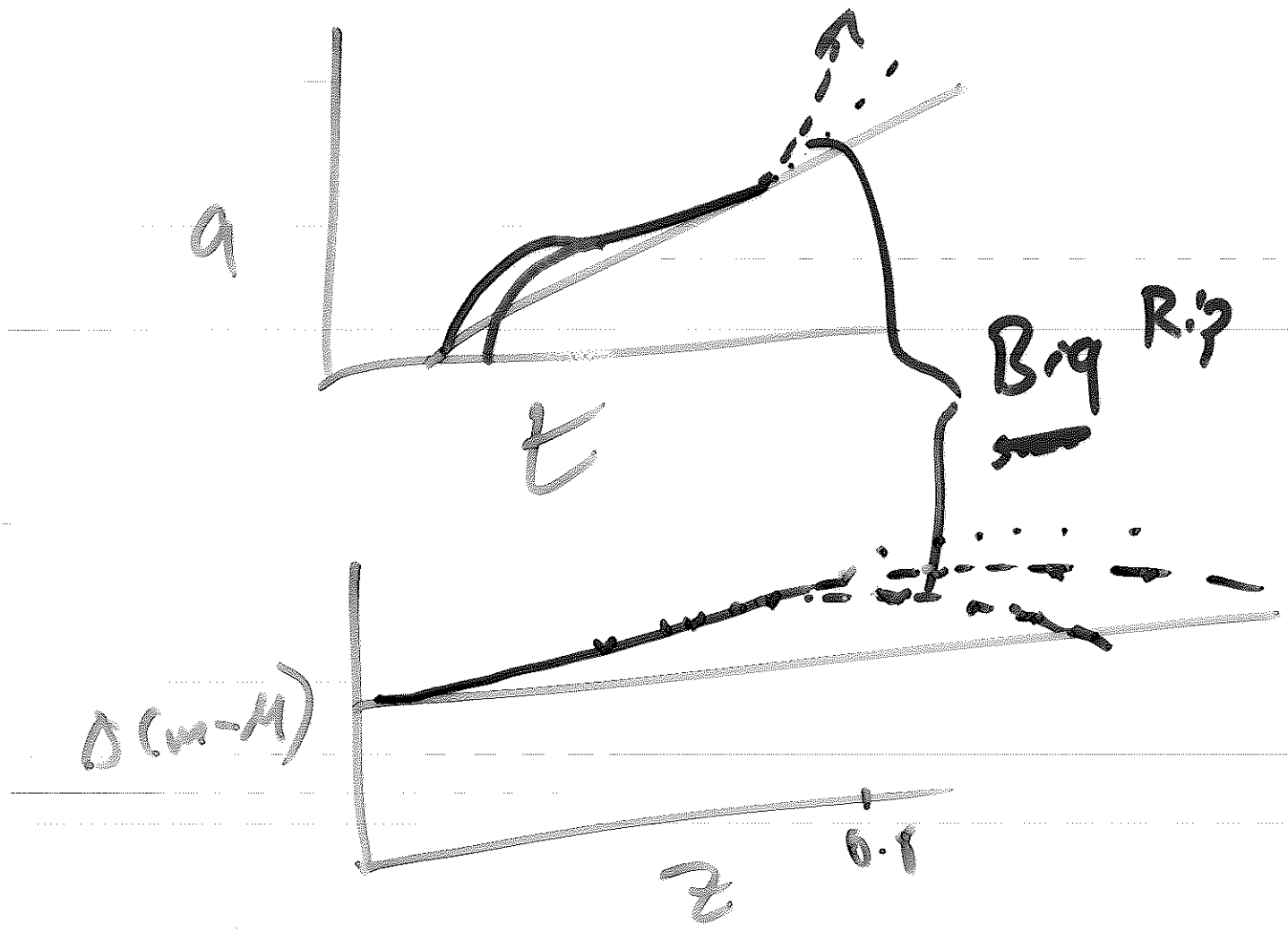
Suppose Dark Energy isn't
constant

D.E. density increases with
time → "Big Rip"

D.E. density was LESS in
past

→ to balance between decel & accel

was more recent



B·q R·p: same expansion now
same accel now
more accel. (future)
more decl (in past)

Spare mission:

JDEM joint dark energy mission

NASA D.O.E.

SNAP supernova & gravitational probe

(example)

Spare telescope:

WIDE FIELD of view

optimized for IR

find many supernovae $z > 1$

Large Synoptic Survey Telescope

LSST

survey of sky every 3 days

$\Rightarrow$ find every low and intermediate z SNe

10^4/yr (x4)

huge statistics to $z = 0.5$

also study details of subclasses of SN

30 Tbytes of data/night