Thurs: PS #9 due
papers due
last lecture

next week: supersection
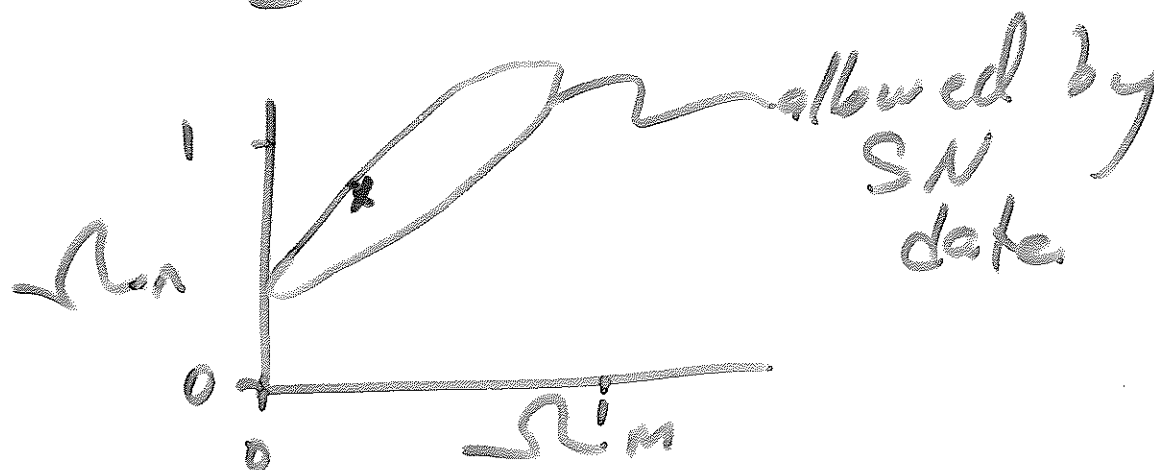
final: LAST PART OF COURSE ONLY
(there will be a review session —
and forum, and office hrs,
and other meetings if desired)

SUPERNOVAE

know that Universe is accelerating

$$\Omega_\Lambda > \Omega_m$$

know by how much bigger
Ω_Λ is than Ω_m

allowed by
SN
data

(assuming D.E. is cosmo. constant)

Cosmic Microwave Background

recall: looking back

densus & hotter

$$Z = 3000$$
$$T \sim 10^4$$

$\hookrightarrow$ H ionize

before that Universe was

opaque

in any direction you should
see hot ionized H

$\hookrightarrow$ surface of star

$$\lambda_{obs} = \lambda_0 + \Delta\lambda = \lambda_0(1+z)$$

$\hookleftarrow \Delta\lambda/\lambda_0$

$$= \lambda_0 \times 3 \times 10^3$$
$$5 \times 10^{-7} \times 3 \times 10^3 = 15 \times 10^{-4}$$
$$\sim 1 \text{ mm}$$

$\nearrow$ microwaves

TRUE: is a cosmic microwave background

in any direction

___

1960s as evidence for BB
against SS

___

Very smooth
same everywhere
MUST be some irregularities
(Universe now irregular
↙
contains objects)

COBE
↳
cosmic Background Explorer
satellite early 1990s

⟹ variations 10^{-5} to 1

(now 10^{30})

another satellite

WMAP

↓ Wilkinson Microwave
  Anisotropy Probe

2003: much more precise map of
            CMB
  → size of irregularities

_____

from sizes ⟹ cosmological
                information

⟹ find out
    $\Omega_{TOT} = \Omega_\Lambda + \Omega_m$

        $= 1 \; (\pm 0.1)$

                $\sim SN_e$

Ω_Λ microwave
                               background

Ω_m

GROWTH OF STRUCTURE

at $z = 3000$ 10^{-5} perturbation

at $z = 0$ 10^{20} + perturbations

slight overdensity
↳ more gravity
↓
pulls in nearby material
↓
denser

$\Rightarrow$ "Large Scale Structure"
distribution of galaxy
& galaxy cluster

$\Rightarrow$ galaxy survey
position in sky
measure z

$\Rightarrow$ 3D map of sky

Simulation growth of structure

Start with CMB
apply gravity
determine what simulation
looks like "now"

does it look same as
observations

assume D.E.
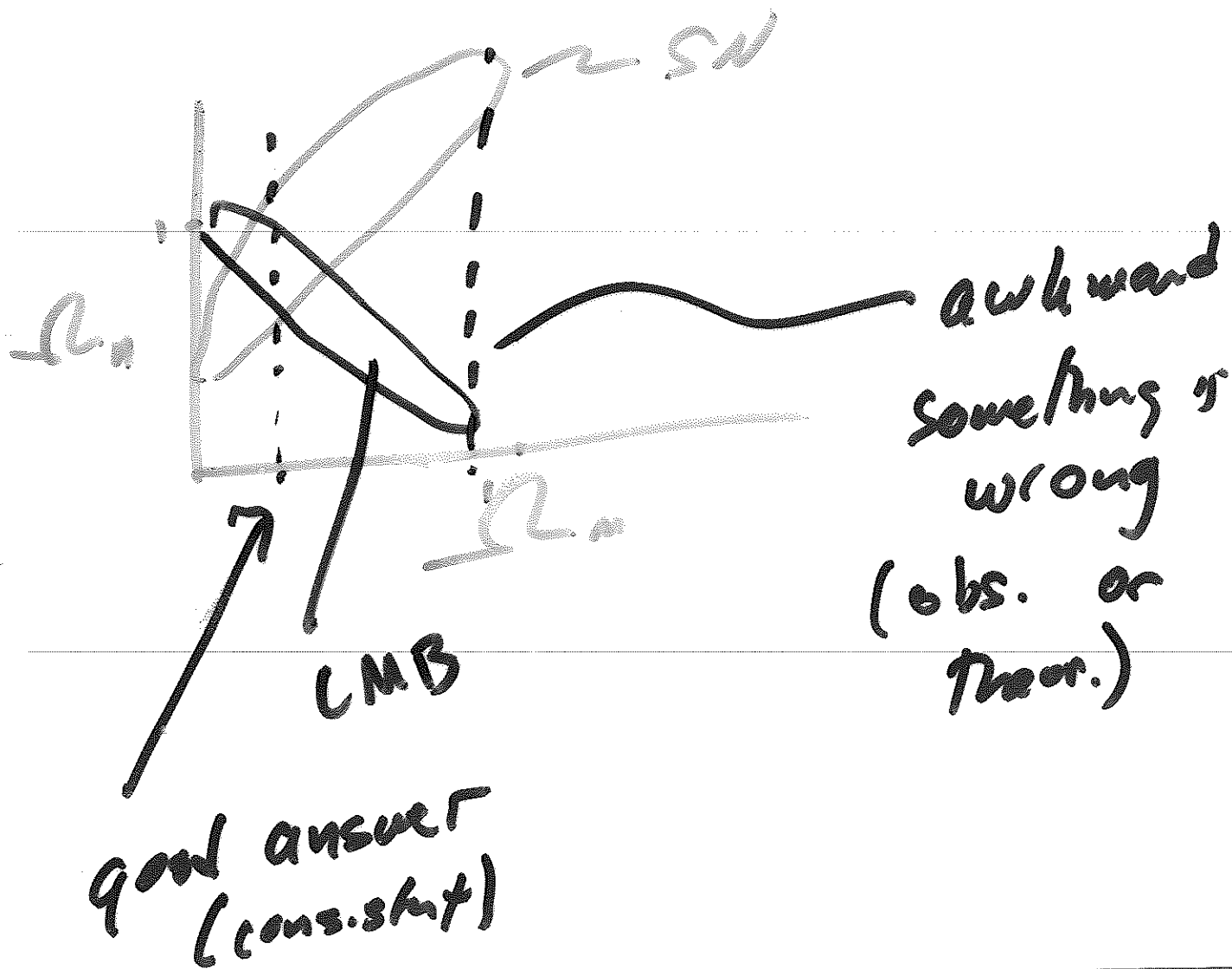how much Dark Matter
@ some of properties

which input parameters
→ observations

compare simulations to
redshift survey

→ clustering Dark Matter

Ω_Λ

awkward
something is
wrong
(obs. or
theor.)

CMB

good answer
(cons.start)

Ω_m

TEST of Cosmology

one measurement of 2 variable
$(\Omega_\Lambda, \Omega_m)$

two measurements of 2 variables
measure values for Ω_Λ, Ω_m

three measurement of 2 variables
TEST OF THEORY