$$m_1 - m_2 = \frac{5}{2} \log\left(b_1/b_2\right)$$

two different object
one kind of magnitude

$$-0.4(m_1 - m_2) = \log\left(b_1/b_2\right)$$

10

$$m - M = 5 \log\left(D/10\,pc\right)$$

one object
both kinds of magnitude

20) $$M_{c1} - M_{c2} = \Delta M_c$$

① $M_{e1} - M_{c1} = 5 \log\left(\frac{De_1/10pc}{}\right)$

② $M_{e2} - M_{c2} = 5 \log\left(\frac{De_2/10pc}{}\right)$

① − ②

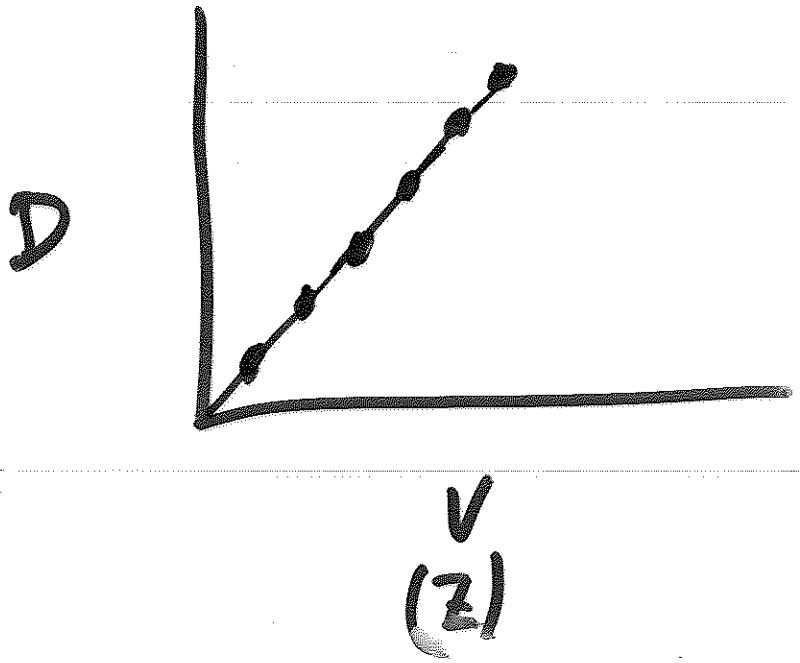
$(M_{e1} - M_{e2}) - [M_{c1} - M_{c2}]$

zero

$= 5\left[\log\left(\frac{De_1/10pc}{}\right) - \log\left(\frac{De_2/10pc}{}\right)\right]$

$\log(x) - \log(y) = \log(x/y)$

+ info elsewhere in problem

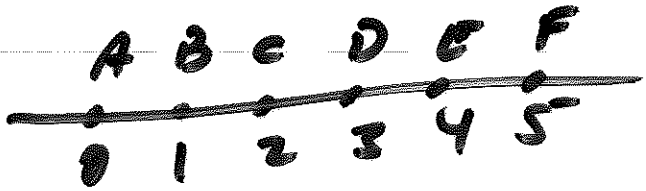


$V = H D$

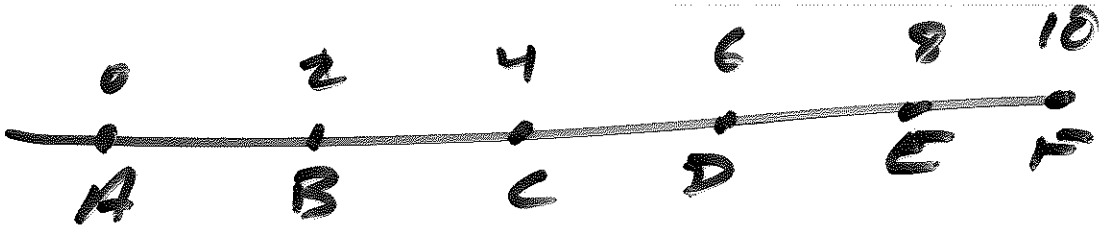
H ← Hubble's constant

⇒ universe is expanding
→ Big Bang
→ age of Universe
→ ultimate fate of universe

ONE D UNIVERSE

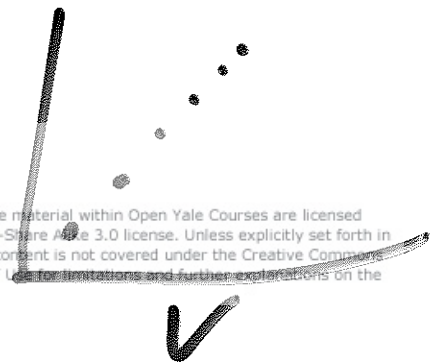


1 time unit



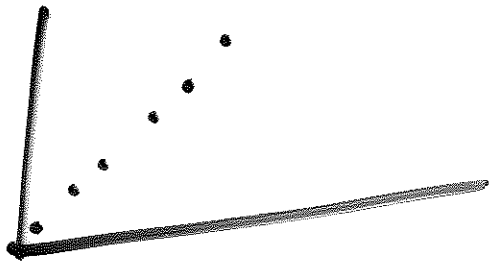
observer on A

galaxy	distance (at start)	motion		velocity $\Delta D/\Delta T$
B	1	1→2	$\Delta D = 1$	$1/1 = 1$
C	2	2→4	$\Delta D = 2$	$2/1 = 2$
D	3	3→6		3
E	4	4→8		4
F	5	5→10		5

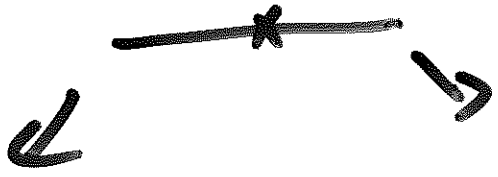


observer on point E

galaxy	distance	motion	velocity
F	1	(4-5) → (8-10) ΔD = -2	1
D	1	(4-3) → (8-6) ΔD = 1	1
B	3	(4-1) → (8-2) ΔD = 3	3

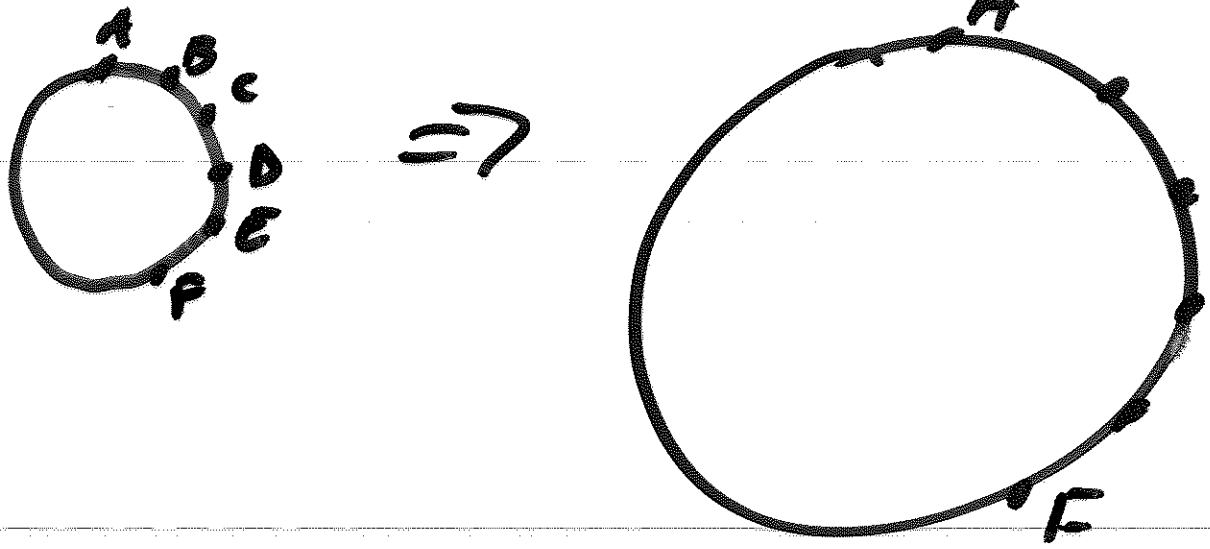


Q1: where is the center?



Q2: what is it expanding into?

BAD ANALOGY



UNBOUNDED
(no edge)
(no center)
expands into higher dimension

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every object has a position x, y, z

$a(t)(x, y, z)$

- a: scale factor
- t: changes in position (velocity)
- (x, y, z): coordinate position

1) motion through coord system
"peculiar" motion

2) effect of change (increase)
in scale factor

---

back in time
$a(t) = 0$

O (x, y, z)
↑
E (x, y, z)