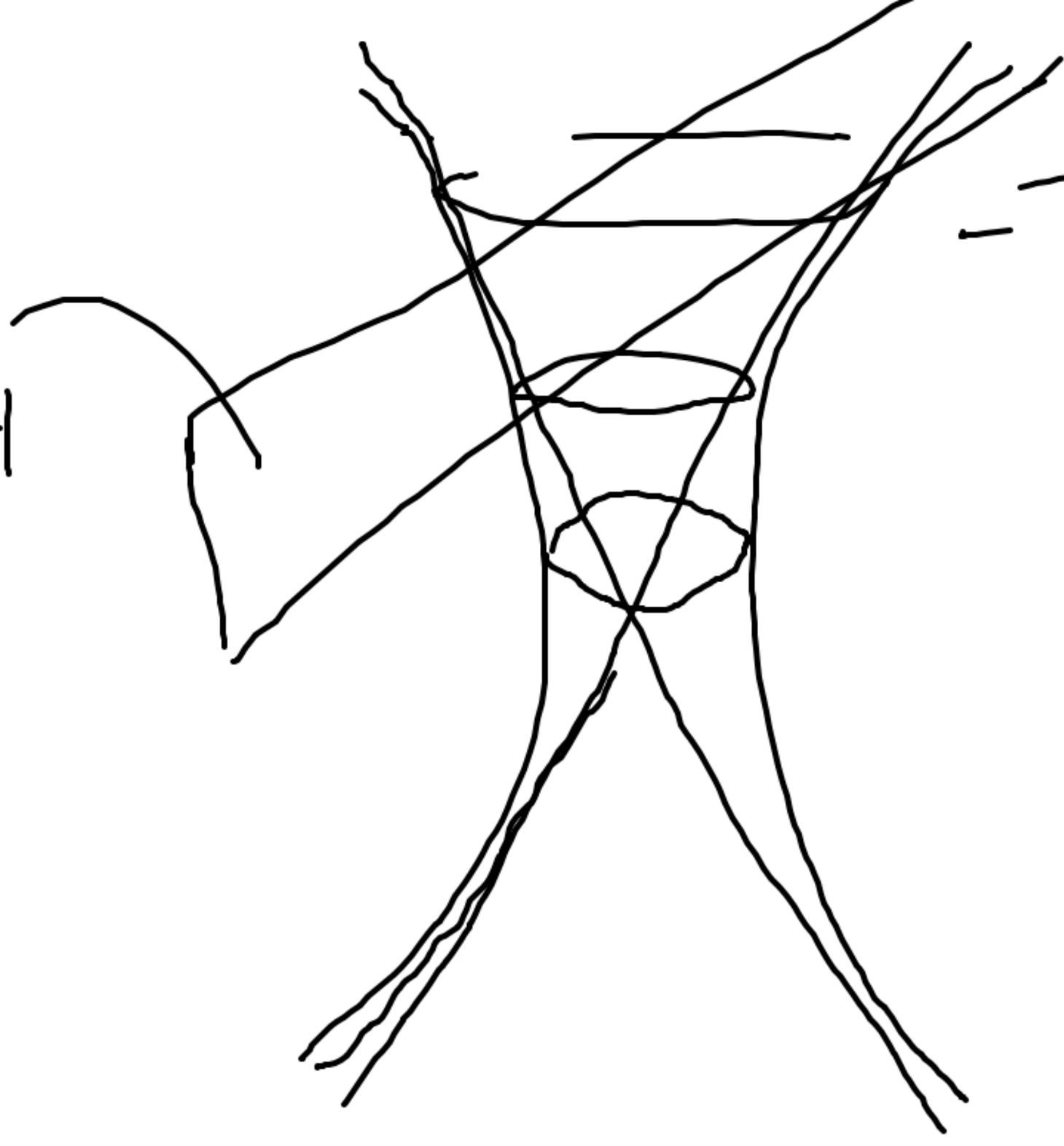
$T - W = \text{const}$

$-T^2 + W^2 x^2 + y^2 + z^2 = T^2$



$$H^2 = -\frac{K}{a^2} + \underbrace{\frac{8\pi}{3} \rho}$$

$$p = \alpha \rho \qquad \frac{8\pi}{3} \frac{\rho_i}{a^{3(1+\alpha)}}$$

$$\phi \rightarrow S = \frac{1}{2} \int \sqrt{g}\, g^{\mu\nu} \partial_\mu \phi \partial_\nu \phi - m^2 \phi^2$$

$$\sqrt{g} = a^3 \quad \text{Volume} \qquad d^3x\, dt$$

$$\frac{1}{a^3}\partial_t a^3 \partial_t \phi + m^2\phi = 0$$

If we assume $\dot{m} = 0$.

$$\ddot{\phi} + 3H\dot{\phi} + m^2\phi = 0$$

$$\left[\partial_t\right]$$

For large H, $m \ll H(\partial_t \phi)$

$$\partial_t \phi = -\frac{m^2}{H}\phi \qquad \partial_t^2\phi \simeq \left(\frac{m^2}{H}\right)^2$$

$m^2/H^2 \ll 1$ Slow Roll

$$H = \frac{8\pi}{3}\rho$$

$$T_{\mu\nu} = \partial_\mu\phi\partial_\nu\phi - \frac{1}{2}\underbrace{\left(\partial_\alpha\phi\partial^\alpha\phi + m^2\phi^2\right)g_{\mu\nu}}$$

$$p = -\rho = -\frac{1}{2}m^2\phi^2$$

$$p = \rho = \frac{1}{2}(\dot{\phi})^2 \Longrightarrow \rho = \frac{\rho_0}{a^6}$$

Not quite

ϕ rolls down hill

eventually $(\dot{\phi})^2$ dominates.

ϕ begins to move faster than H $\left(\frac{\dot{\phi}}{\phi} > H\right)$

$\frac{m^2}{H^2} \ll 1.$

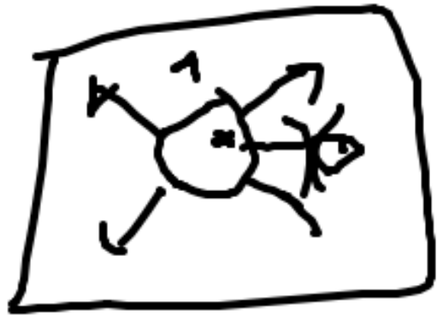
$H^2 = \frac{8\pi}{3}\rho = \frac{8\pi}{3} m^2 \phi^2$

If $\phi \gg 1$

Puzzles: flom. + Isotr.

$m^2\phi^2$ → $V(\phi)$

$V(\phi) \simeq 0$



LINDE - Slow Roll Inflation

$$\frac{1}{a^3}\partial_t a^3 \partial_t \psi_k + \frac{k^2}{a^2}\psi_k = 0$$

$e^{ik\cdot x}$ If $H^2 > \frac{k^2}{a^2}$

Then ψ_k roughly const.

$\lambda_{ph} > \frac{1}{H}$ then ψ does not change much.

$$\int a^3 (\partial_t \phi)^2 - a (\partial_x \psi_1)^2$$

$$\Downarrow$$

$$H_K = \int \frac{\Pi^2}{a^3} + k^2 a \psi^2$$

$$\Delta \pi_1 \Delta \psi \Rightarrow h = 1$$

$$H_K \simeq \frac{\Delta \Pi^2}{a^3 \Delta \psi^2} + k^2 a \Delta \psi^2 = E_K$$

$$\Delta \psi^2 = \frac{1}{k^2 a^2}$$

$\Delta\psi$ becomes much larger than Ω. minimum.

& E_K becomes >> tw.

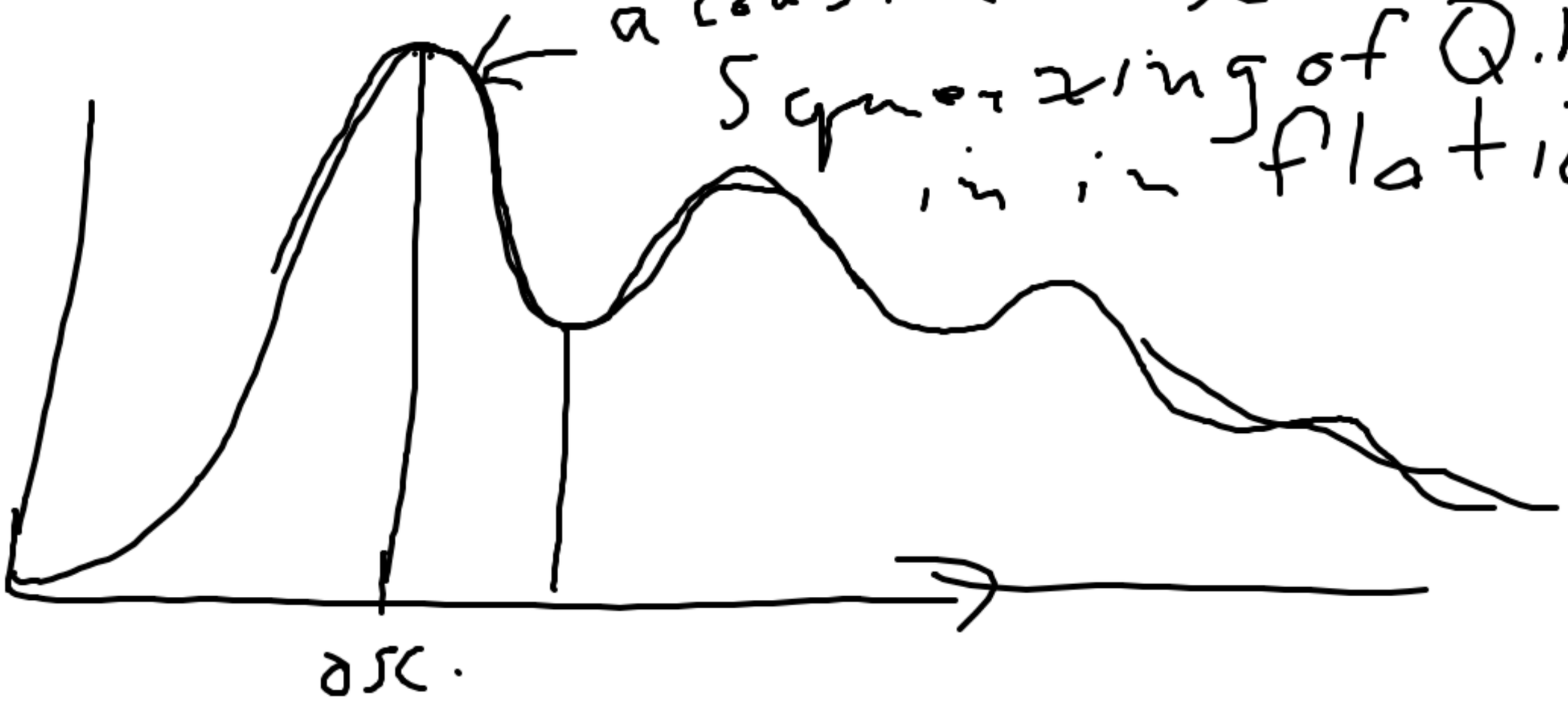
$\Delta\pi \rightarrow$ Squeezed States.

Squeezed State.

As universe expands
+ the H grows.
– This excess energy fluctn
of mods – seeds for
galaxy growth.

Scale invar fluctns.

$\Rightarrow$ CMB. structure.



Cephid. + S.N Ia

$\Rightarrow H \sim 74$ km/sec/Mpc

CMB ~ 67 "/s/Mpc

± 2 km/s/Mpc

5σ discrepancy.

New Physics?