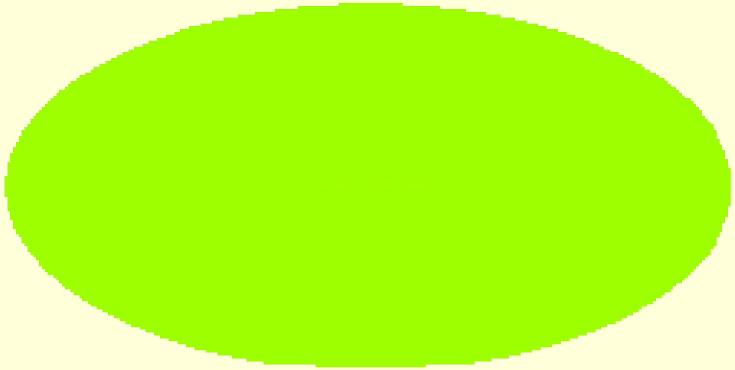
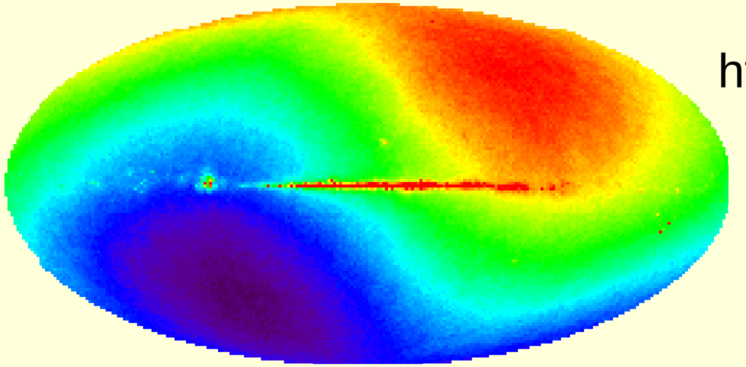
# Inflation And Cosmological Structure

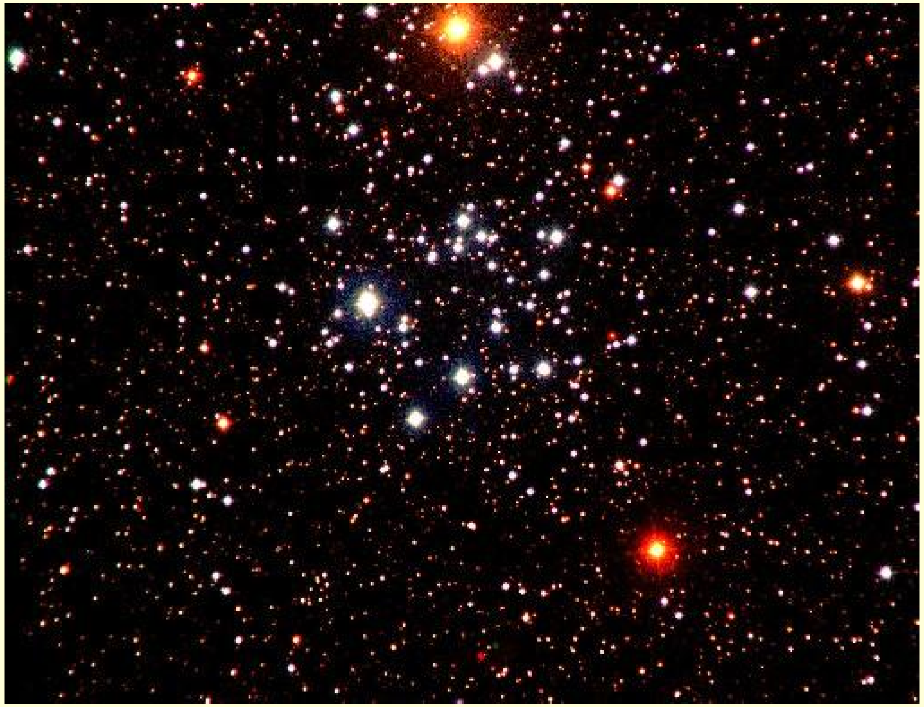
黃世和

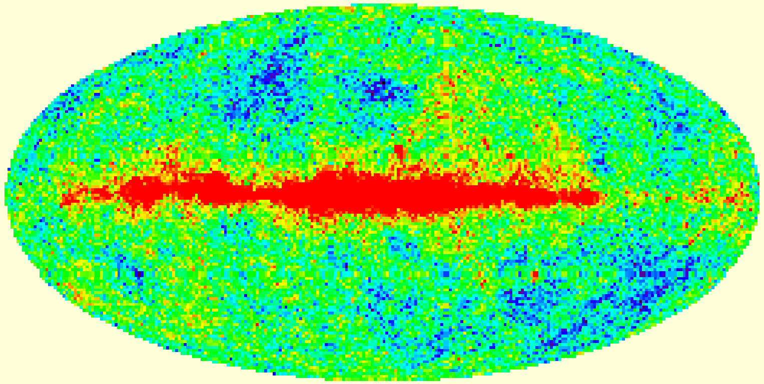


http://map.gsfc.nasa.gov/m_uni/uni_101Flucts.html

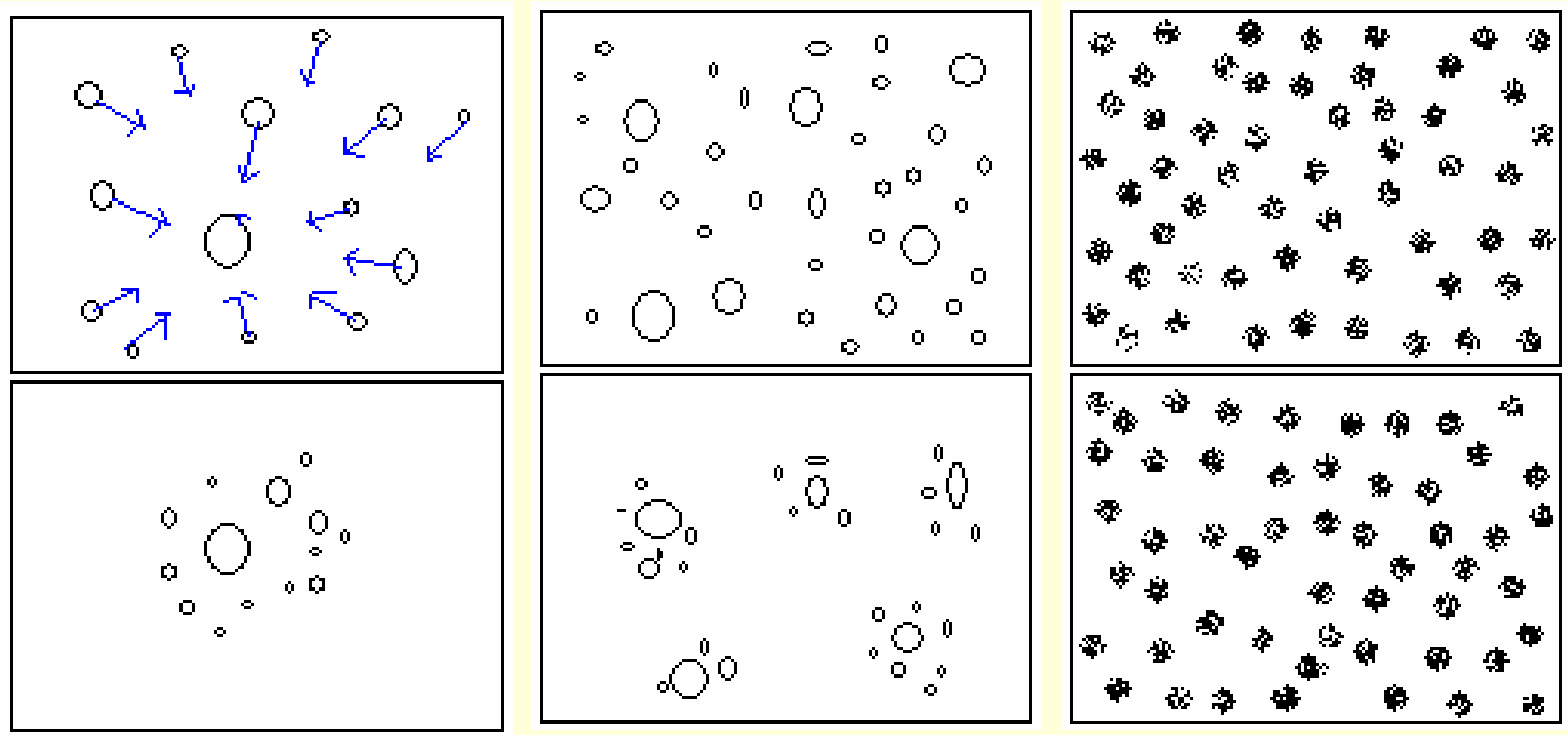


http://antwrp.gsfc.nasa.gov/apod/ap970128.html





# Gravitational Instability



# Jeans Theory

(nonexpanding universe)

$$\frac{\partial \varepsilon}{\partial t} + \nabla(\varepsilon V) = 0$$

$$\frac{\partial V}{\partial t} + (V \bullet \nabla)V + \frac{\nabla p}{\varepsilon} + \nabla \phi = 0$$

**Gravitational V.S. Pressure**

$$\frac{dS}{dt} = 0$$

$$\nabla \phi = 4\pi G \varepsilon$$

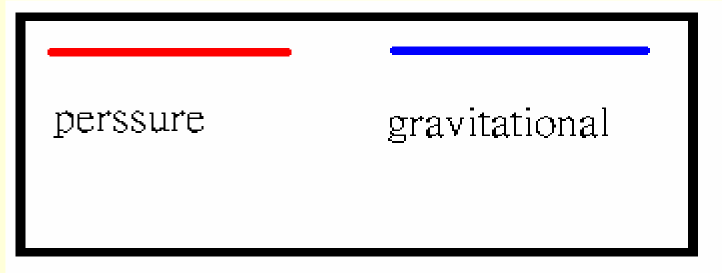
$$f(x,t) = f_0 + \delta f(x,t)$$

**Linear perturbation**

$$\frac{\partial^2 \delta\varepsilon}{\partial t^2} - {c_s}^2 \Delta \delta\varepsilon - 4\pi G \varepsilon_0 \delta\varepsilon = \sigma \Delta S(x)$$

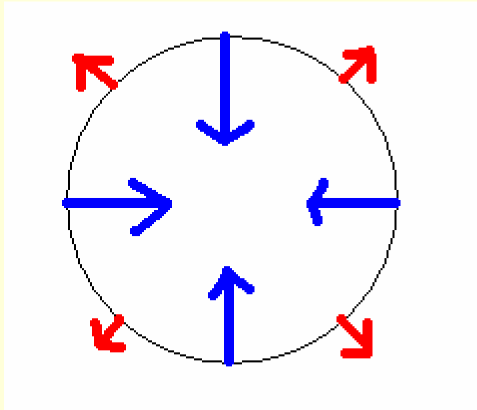
$$M_{Jeans} = \frac{\pi \varepsilon_0}{6}\left(\frac{\pi c_s^{\,2}}{G\varepsilon_0}\right)^{\frac{3}{2}}$$

$$\lambda_J = c_s\left(\frac{\pi}{G\varepsilon_0}\right)^{\frac{1}{2}}$$



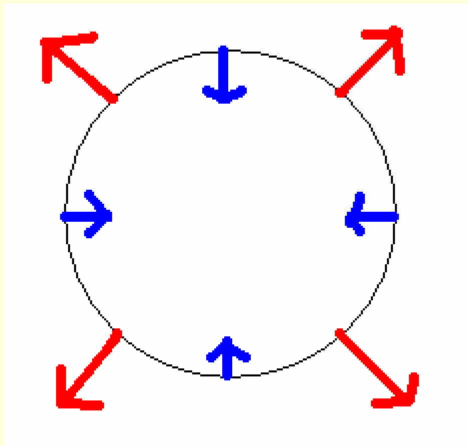

$$M > M_J \Rightarrow collapse$$

$$\lambda > \lambda_J$$



$$M < M_J$$

$$\lambda < \lambda_J$$



# Peeble-Harrison-Zelovich

- The density fluctuation obeys some law if they are to develop into galaxies.
- The result is independent of the actual value of the threshould epoch,and equation of state for the early universe.
- Predicts angular momenta of galaxis.

$$\delta(k)^2 P \propto k^{n_s}, \xi\left(\bar{r}\right) = \int d^3k e^{-ik\bar{r}} P(k,\eta), n_s = 1 \qquad \text{(flat)}$$

# Inflationary Cosmology For Initial Perturbations

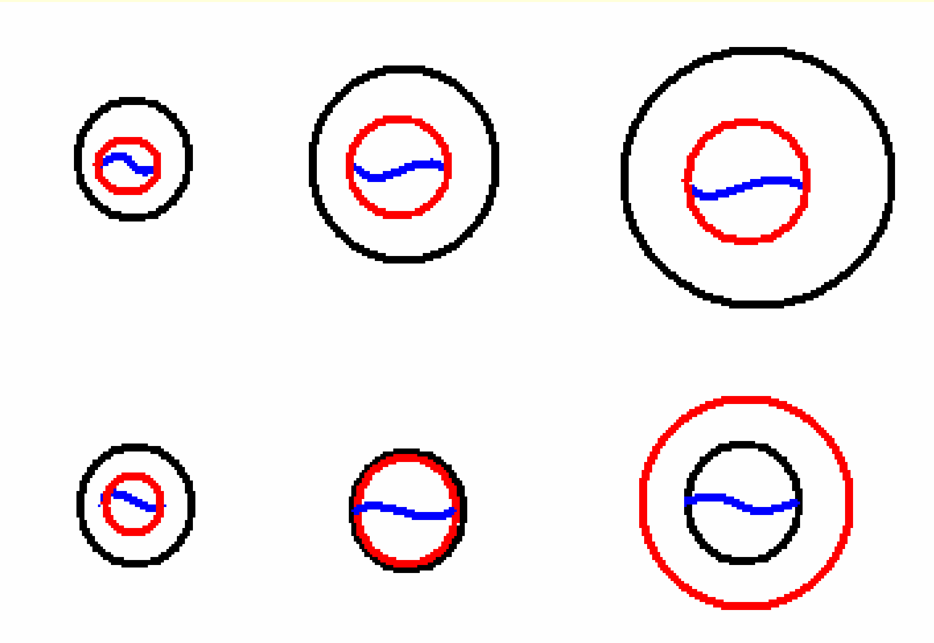
- 1.Quantun Fluctuations

$$V\left(\phi\right)=\phi^{\nu}$$

- 2.Inflation made physical length grews fast.
- 3.Satisify the power spectrum(nearly scalar invarient)

$$a \propto t^{\frac{2}{3+3w}}, H^{-1} \propto t(w \neq -1), a > H^{-1} \text{when } (w+\tfrac{1}{3})(w+1) < 0$$

$$a \propto e^{H_\Lambda t}, H^{-1} = H_\Lambda{}^{-1}$$



$$\delta^2(k) \propto k^{n_s - 1}$$

Density(scalar) Perturbations

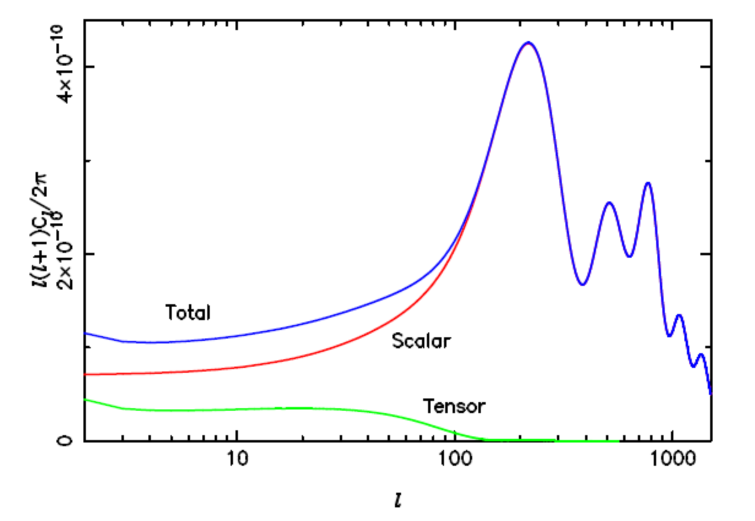
$$A_T^{\,2}(k) \propto k^{n_T}$$

Gravitational waves (tensor Perturbations)

$$\frac{T(\theta,\phi) - \bar{T}}{\bar{T}} = \sum_{l,m} a_{lm} Y_m^l(\theta,\phi); C_l = \left\langle \left| a_{lm} \right|^2 \right\rangle$$

Angular power spectrum

The simplest models of ination predict nearly power-law spectra of adiabatic, gaussian scalar and tensor perturbations in their growing mode in a spatially-at Univers.



# 整理

- 1.星系結構的形成爲重力與壓力的對抗結果，起始條件會有一定的限制才不會讓宇宙星系全坍在一起或無法形成結構。
- 2.暴漲模型提供了上述問題所需的譜線（但與使用的位能方法相關。）
- 3.測量上可利用純量擾動（星系結構）與背景輻射不均向（重力波擾動）。

# More interesting problems

- Chaotic Inflation?

# References


- 1.our textbook
- 2.arXiv:astro-ph/0404546 (Guth對暴漲理論的整理)
- 3.arXiv:astro-ph/0109439(Liddle對暴漲理論，特別是初始值問題簡單的介紹)
- 4. arXiv:hep-ph/9904502（Lazarides對宇宙學的簡介）
- 5.E.R.Harrison,Phys.Rev. D 1 (1970 2726)
- 6.YA.B.Zelovich,Astron.＆Astrophys.5,84-89(1970)
- 7. arXiv:hep-th/0703173 (Brandenberger關於時空不可交換的弦理論，以及宇宙結構問題的簡介)