

## Chapter 1 系统理论

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杨还一层观可	~10 <sup>23</sup> 个科的量的 浏的物理量	[单组合. 均相]	
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/ 能士 E		<b>度</b> T	
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统计力学: 微	rap t <u>统计</u>	—— Pan #	
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優方を 热力学	E A B		
	≥ property 10 mg	译 define 等价关系,"温度"	10
统计力		压,演化停滞。─→福气间	概率3种不变. 贵 ??
	② 混乱傷東か	信息煽最小 ← 信息论	
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	$\int_{0}^{\infty} \theta(T) dT = \langle \theta \rangle_{\rho}$ $12.                                    $	← 乔狝牛冈 瓦化轨迹,可从遍近相空间上F	· - · · · · · · · · · · · · · · · · · ·
	的 <i>的</i> 潜演化的时间尺度		E, (₹, ^ 1,5~)
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			f q= aH
(流计为学基础)	榧有河" 「:⊕;Ω;	Ni = P, ⊕9i	$\dot{p} = -\frac{\partial H}{\partial q}$
租	空间-1点 a∈厂,代表1	体系的一个状态。	Ť
	空间厂上的概率分布	[条统的众务副本在相空间不同	
流体: Euler 起连:	{ Atβ+ v.j=0		 "流(本"
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J	] = V P V = (2	育, <b>芹</b> )	
			÷1/87 +49
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			刘维本方程
$\longrightarrow \frac{\partial \rho}{\partial t} + \sum \left( \frac{\partial \rho}{\partial q} - \frac{\partial \rho}{\partial q} \right)$	1 - 3p 31 ) = 0 -		浏绳车节型
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小系统、
                         N. V. T
                                                                                  Bath → equilibrium
.
龙处于ν的概率:
                                              秦徐双于v辰. 凡:1
                                                                                       EB. T
Pr or NulTotal) = No. As
                                                3 Etotal = En + EL = const
      = No (E - EL)
Inste = Instalt) - DE
                                                                                      V. Ev
 = Install - BREx
                                                   BB=B=FT
                                                                                   system << Bath
\rightarrow Pr \propto e^{-\beta E_{r}}
                            Pp En Pu=1
  Pr = de e fer Q = Zre-per = Q(N.V.T)
                                                                               正则配分函数。
                         连续化 = J dE JUE) e PE
                                                                            Лив): 态窟度/能级简美度
1值与涨落
 \langle E \rangle = \frac{1}{2} \sum_{i} E_{i} e^{-\beta E_{i}} = \frac{1}{\alpha} \sum_{i} \frac{\partial}{\partial U_{\beta}} e^{-\beta E_{i}} = \frac{1}{\alpha} \frac{\partial \Omega}{\partial U_{\beta}} = \frac{\partial \ln \Omega}{\partial U_{\beta}}
\langle (\delta E)^{2} \rangle = \langle E^{2} \rangle - \langle E \rangle^{2} = \frac{1}{\alpha} \sum_{i} E_{i}^{2} e^{-\beta E_{i}} - \left(\frac{1}{\alpha} \sum_{i} E_{i} e^{-\beta E_{i}}\right)^{2} = \frac{\partial \ln \Omega}{\partial U_{\beta}} = kT^{2} C_{V}
から: dE= TdS-PdV+ udN
            dF = -SdT - PdV + udN
\longrightarrow \frac{\partial}{\partial \tau} \left( \frac{F}{T} \right) : \frac{1}{T} \frac{\partial F}{\partial \tau} - \frac{1}{T^2} F := -\frac{F + TS}{T^2} := -\frac{F}{T^2} \frac{\partial h R}{\partial l - \beta} := -\frac{\partial}{\partial \tau} \left( \text{khR} \right)
→ F =-KT/NQ + T fun.v)
FT S=- OF = KIND+ (E) - f(N,V)
                                                  取 N.V=ロ → Q=1 S=0 E=0 → f=0
S=k(InQ-BobbenQ)
                                                    G_{E}^{2} = \frac{\langle (SE)^{2} \rangle}{\langle E \rangle^{2}} = \frac{kT^{2}Cv}{\langle E \rangle^{2}} \sim \frac{N}{N^{2}} = \frac{1}{N}
U= - 3 InQ
                                                  ideal gas : 6e^{2} = \frac{kT^{2}\frac{3}{2}Nk}{(\frac{3}{2}NkT)^{2}} = \frac{2}{3N}
F=-KT InQ
-BP = - 3v InD
 BA = - 3N Ina
           PLE) = ALE) e-BE/Q
         Inple) = Insle)-BE-InQ.
                                                            考察 E=〈E〉+ AE 的概率
                  = In P(CEY) + Jhp DE+ 1 Jhp (OE)
    IP DE LES B-B-0
         \frac{\partial E_{3}}{\partial y^{2}h^{2}} = \frac{\partial E_{3}}{\partial y^{2}h^{2}} = \frac{\partial E}{\partial h^{2}} = -\frac{\langle (8E)_{3} \rangle}{|V|}
      \longrightarrow |m|_{(E)} = |m|_{(\langle E \rangle)} - \frac{1}{7} \frac{(\langle E \rangle)_7}{(\langle (E)_7)_7} = |m|_{(\langle E \rangle)} - \frac{1}{7} \frac{(\nabla E/\langle E \rangle)_7}{\langle (E \rangle)_7}
     而 62~ ~ 10-23
                                                        DE/(E) ~ 10-10
      → PLE) = P(<E>) e -500 <<1
南禹 (E),即使很办. 也几乎不可能出讯.
      P(<E>) 最概点筛 = 真实饰
义系统
                                                                        JĒĿR): X=N. ζ=-βм
                                                                        「筝左 : x = V /
                         Pr= = e-BBr-LXL
因正则系综
                          日= Zre-por-ZXr =日(T,Z,...)
                         \langle (8E)^2 \rangle = -\frac{\partial \langle E \rangle}{\partial \beta} = \frac{\partial^2 \ln E}{\partial \beta^2}
\langle (8X)^2 \rangle = -\frac{\partial \langle X \rangle}{\partial \zeta} = \frac{\partial^2 \ln E}{\partial \zeta^2}
   dE= Tds-pdv+ udn = Tds-kTSdx
p dh函=-Edβ-xds
→ dS= + dE+ K3dX= d(++K3x)-Ed(+)-KXd3
           = d(KN日+ 年+ K3x)
→ 5= k(mil + βE + 3x) = k(1-β3β- 33) mil
正则系综。
                                T. V. M
        = Z, e-BE, +BAN, = Z, e-BE, - WAL
                                                                              d=-BM
        Pr= Erenn
                  J=U-TS-MN = -KT MEI
动学,
                                                                               d]=-SdT-PdV-Ndn
                   U=-3g加田
                   S= k(1-β3β-α3α) In[H]
                  N= - da hili = dign hili
                  BP= 水加田
```

等元系館 T.P.N Z = Z, e <sup>-βEL-βPVL</sup>	
Z = Z, e por pro	
Pr= Ze-BEr-BPV	
世から、G=U-TS+PV=-KT MZ dZ=-SdT+VdP+MdN	
$U = -\frac{\partial}{\partial \beta} \ln Z$ $S = k \left( 1 - \beta \frac{\partial}{\partial \beta} - P \frac{\partial}{\partial P} \right) \ln Z$ $V = -\frac{\partial}{\partial (\beta N)} \ln Z$ $M = -\frac{\partial}{\partial (\beta N)} \ln Z$	
S	
3: +( + psp 1 sp / me	
V = - 34p) M Z	
M= - albu) lnz	
$\frac{3\nu}{8} = \frac{3(8\nu)^2}{3} = \frac{3(8\nu)}{3(8\nu)} = kT k/v \sim \frac{1}{9}$ $6\nu^2 = \frac{3(8\nu)^2}{3(8\nu)^2} = \frac{3(8\nu)}{3(8\nu)} = kT k/v \sim \frac{1}{9}$	
Foi = (SNI) / (N) = KT K/V ~ TI	
DN - ((01)) / (N) - F   E/V -	
10012 - JKVZ - LI DV - LT RV L - 1 DV	
$\langle (SV)^2 \rangle = -\frac{\partial \langle V \rangle}{\partial (\beta P)} = -kT \frac{\partial V}{\partial P} = kT \kappa V$ $\kappa = -\frac{1}{V} \frac{\partial V}{\partial P}$ $\kappa = -\frac{1}{V} \frac{\partial V}{\partial P}$	
6v = <(&V)) / <v> = kT k/v ~ N</v>	
3127 $dE = TdS - pdV + \Sigma_i \mu_i dN_i$ $\begin{cases} \beta = \frac{\partial \ln \Omega}{\partial E} \\ \beta P = \frac{\partial \ln \Omega}{\partial V} \\ \beta \mu_i = -\frac{\partial \ln \Omega}{\partial N_i} \\ E = \Sigma e^{-\beta E_V} e^{-\Sigma_i \alpha_i N_i} \end{cases}$	
SB= DINC	
BP= 3/ns	
Russ - alma	
γ <sub>i</sub> - σ Ni - Σ ο -βε <sub>ν</sub> - Σιαί Νi	
田= < K, 6	
吴联	