

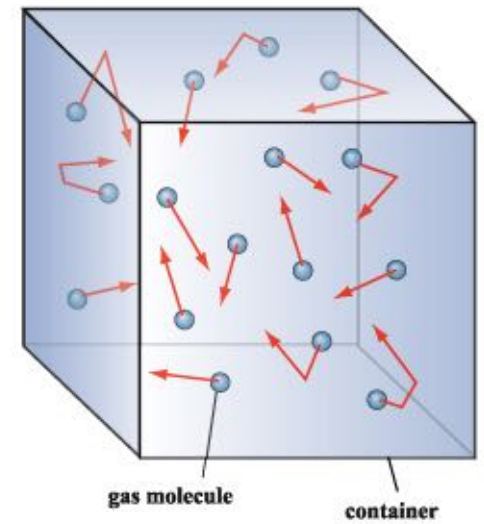
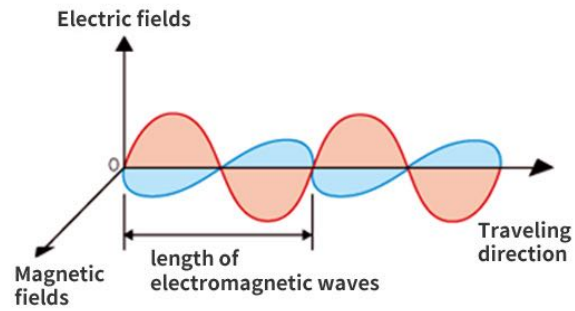
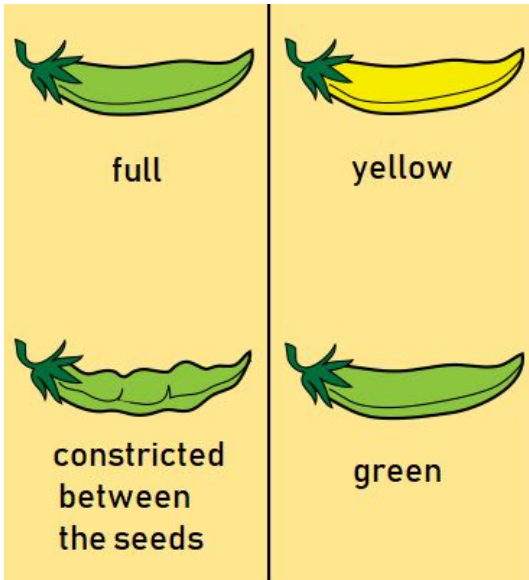
*Brit. J. Phil. Sci.* **51** (2000), 115–145

# Multiple Realizability and Universality

Robert W. Batterman

# Outline

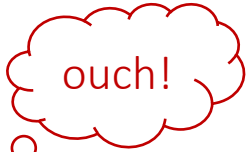
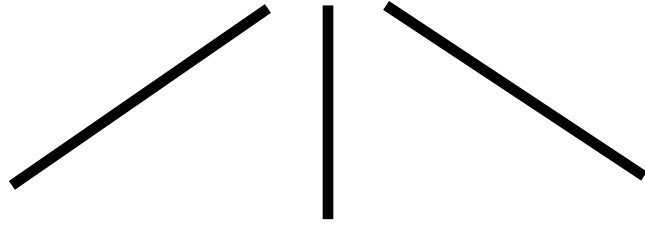
- what's the problem?
- what's Batterman's position?
- renormalization group
- special sciences



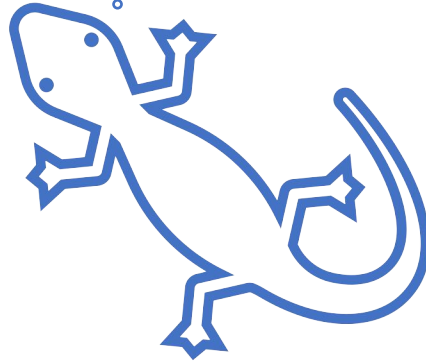
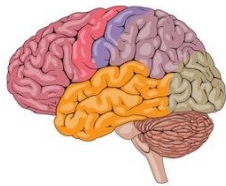
## Multiple Realization Thesis:

upper-level properties are potentially realized by a wide variety of heterogeneous lower-level physical states

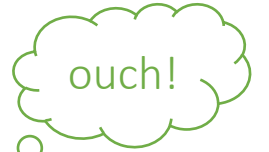
$N$



$N_h$



$N_r$



$N_m$





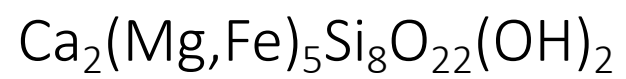
Jade



Jadeite



Nephrite



Pain:  $N \stackrel{?}{=} N_h \vee N_r \vee N_m$

'pain' *is* a  
psychological kind

'pain' *is not* a  
psychological kind



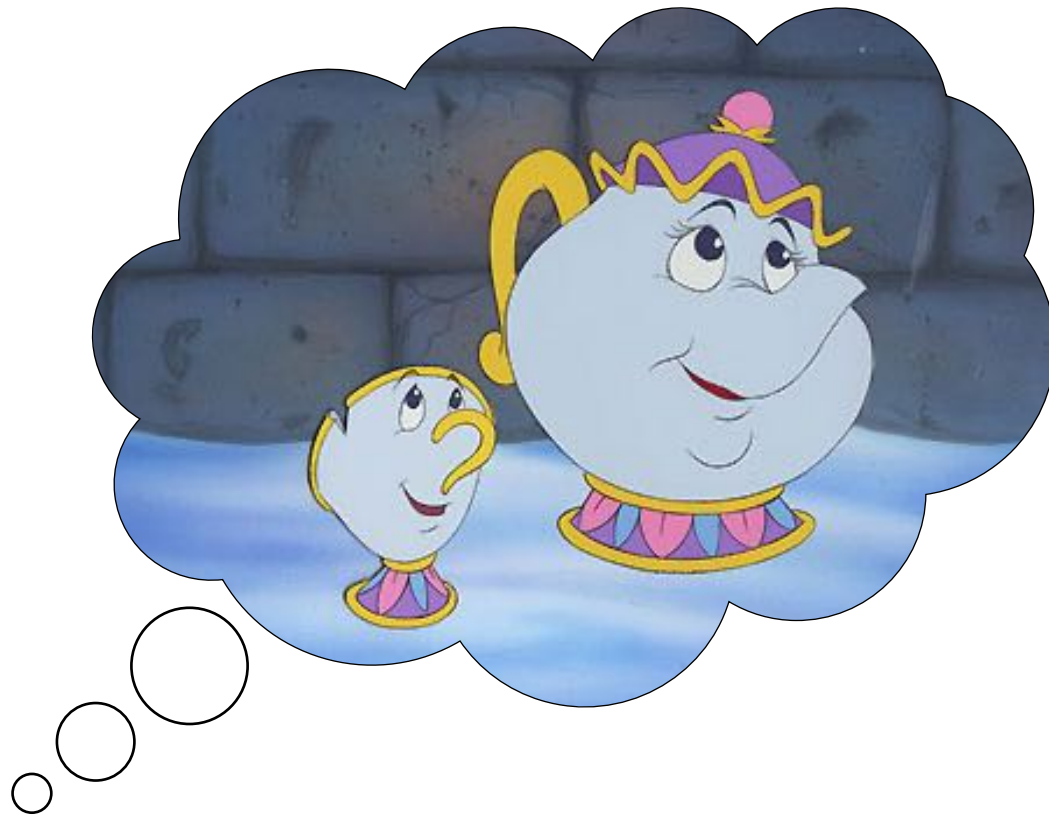
how is it possible for macro-level regularities to be heterogeneously multiply realized?







how is multiple  
realization possible?



multiple realization  
*is not* possible



multiple realization *is*  
possible, but we're not  
really sure how



multiple realization *is*  
possible, *and* there are  
some sort of constraints...



multiple realization *is*  
possible, *and* there are  
some sort of constraints...  
in the form of *universality*



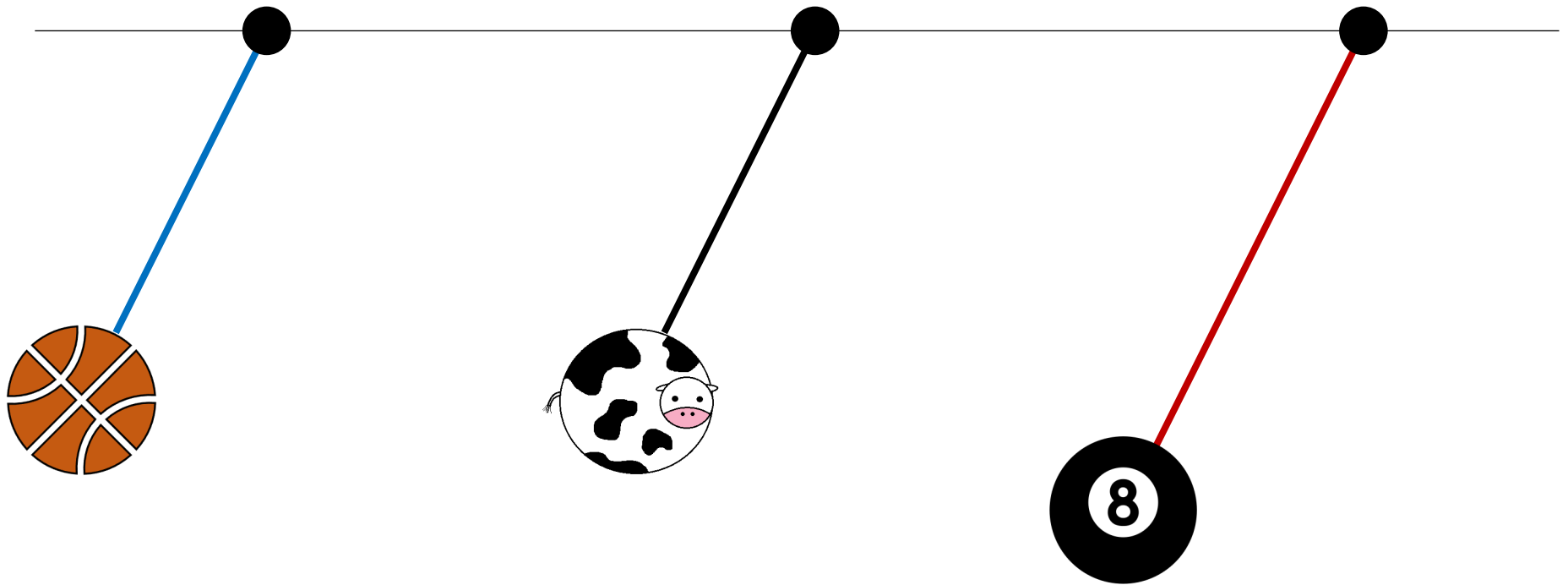
# To Be Established

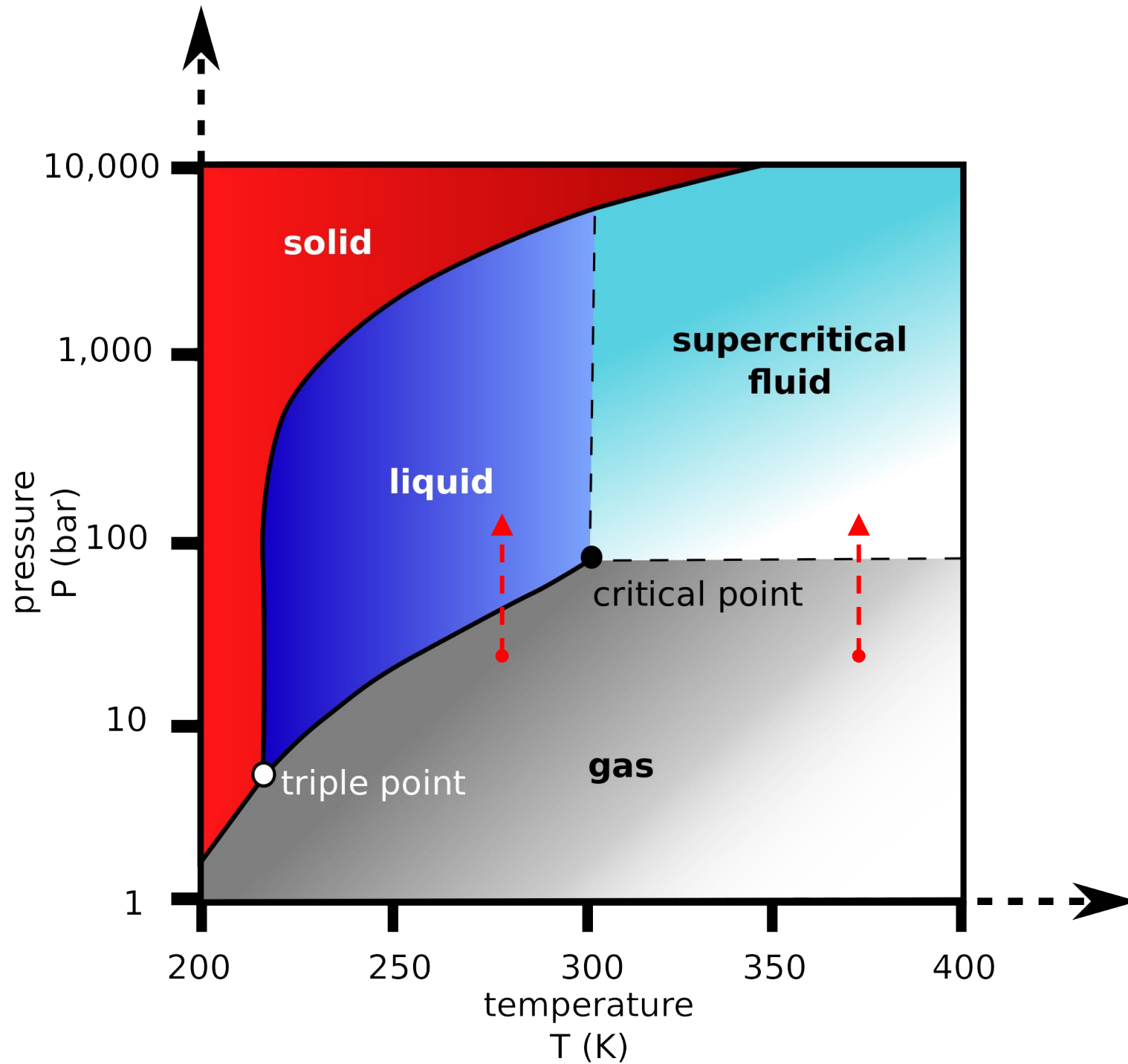
1. the phenomenon of multiple realizability is an instance of universality
2. it is reasonable to expect that the same sort of strategy can be broadly applied to the special sciences

*universality* concerns similarities  
in the behavior of diverse systems



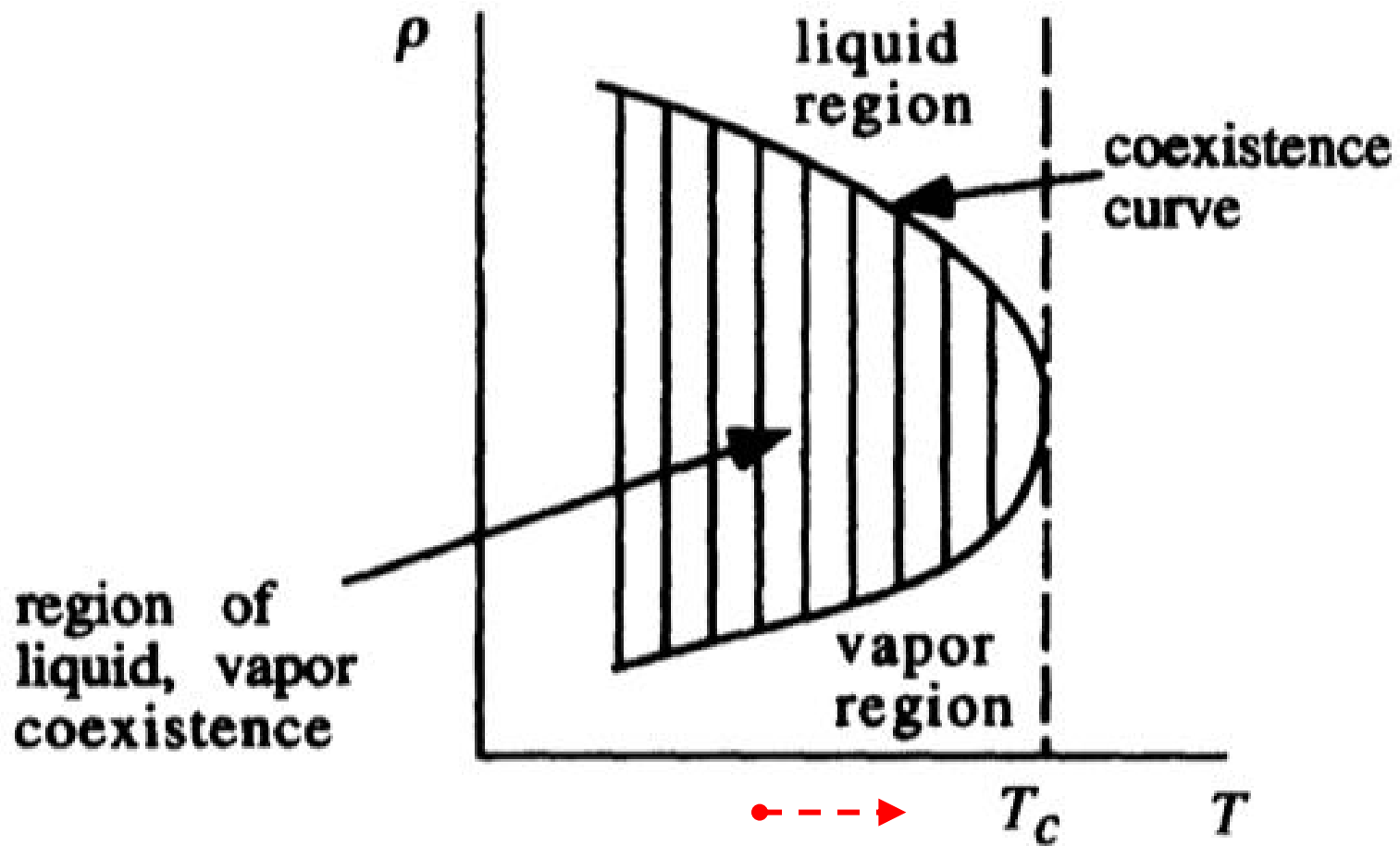
$$\text{period of oscillation} = 2\pi \sqrt{\frac{\text{length of rod}}{\text{gravitational acceleration}}}$$





# Universality

1. the details of the micro-structure of a given fluid are largely *irrelevant* for describing the behavior of the particular system of interest
2. many different systems with distinct micro-structures exhibit identical behavior characterized by *the same critical exponent*



$$\Psi = \rho_{liq} - \rho_{vap} \sim \left| \frac{T - T_c}{T_c} \right|^\beta$$

$$\beta \cong 0.33$$

$$\Psi_F = \rho_{liq} - \rho_{vap} \sim |t|^{0.33}$$

$$\Psi_M = M \sim |t|^{0.33}$$

$$i\hbar \frac{\partial}{\partial t} |\psi(t)\rangle = \hat{H} |\psi(t)\rangle$$


$$\Psi_F \sim |t|^{0.33}$$

# Renormalization Group

- Hamiltonian
- weak correlations
- correlation length
- critical point
- infinities
- **renormalization**

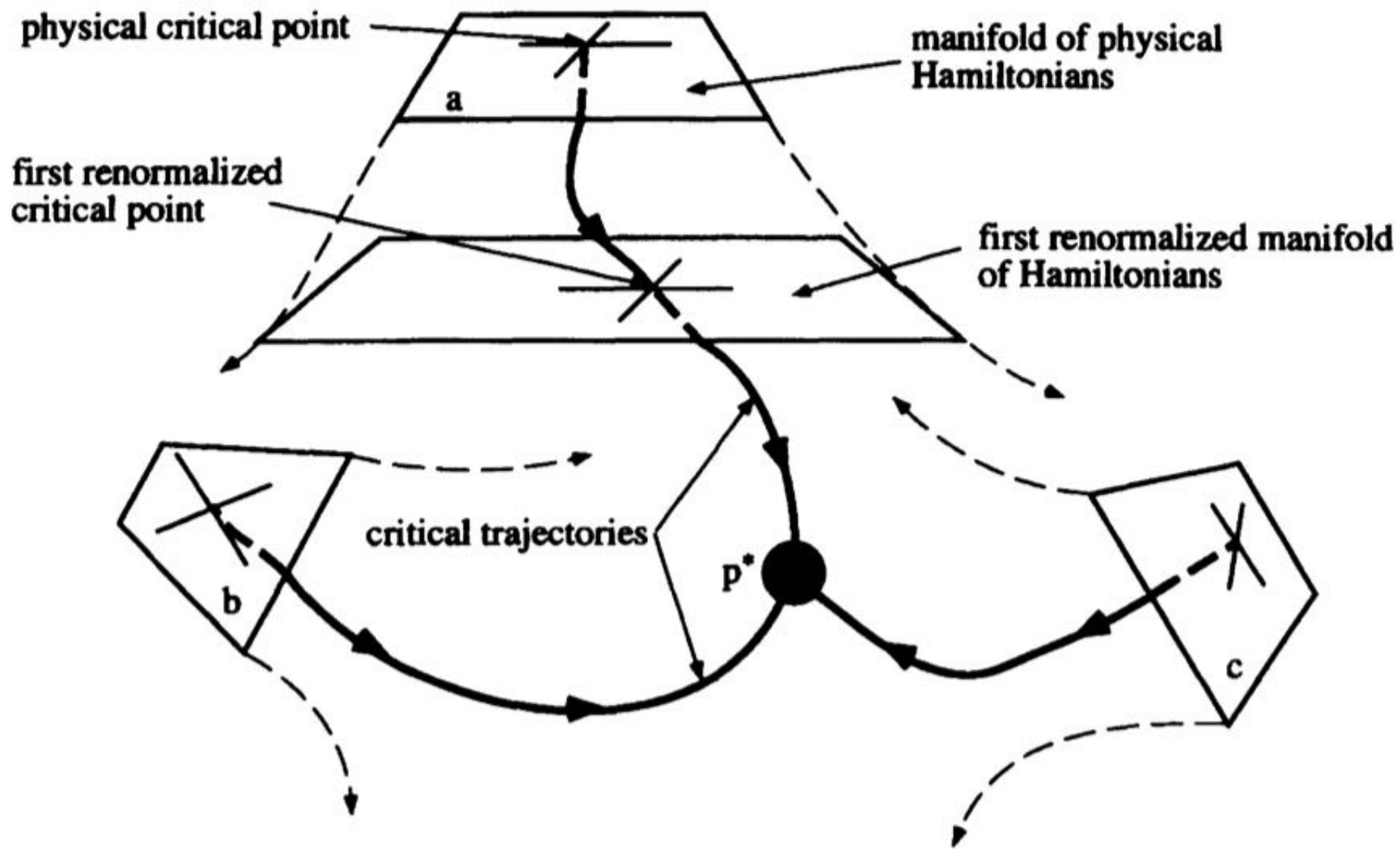


Fig 7. Universality of critical phenomena. Critical trajectories are bold lines.  $p^*$  is a common fixed point for the three distinct physical critical points on the manifolds  $a$ ,  $b$ , and  $c$ .



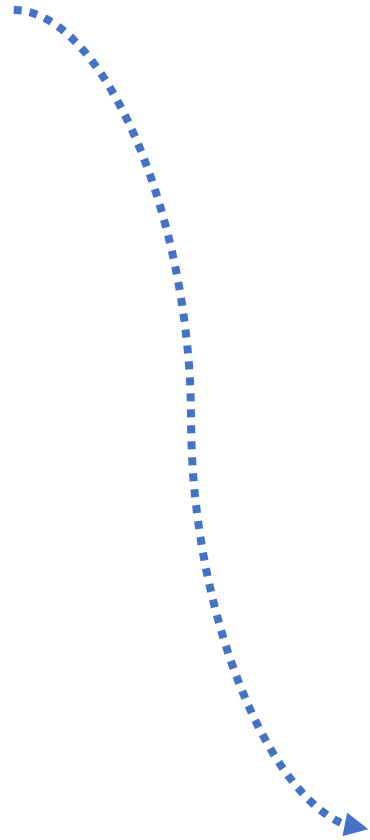
# Summary

- stability under perturbation
- relevant properties
- lower-level properties
- **upper-level properties**

# Explanatory Strategy

- detail independence
- universality classes
- asymptotic analysis
- stability under perturbation
- **multiple realization**

renormalization group  
explanatory strategy



special sciences



how is multiple  
realization possible?

$\exists, \phi_p$



$\alpha, \gamma$



# Gems



pushing past the point of intractability



existence proof



**two-part strategy**

# Discussion

- how successful was Batterman in establishing that universality is an instance of multiple realizability?
- how successful was Batterman in extending this analysis to the special sciences?

