

# Chemical Oceanography



Dr. David K. Ryan

Department of Chemistry

University of Massachusetts Lowell

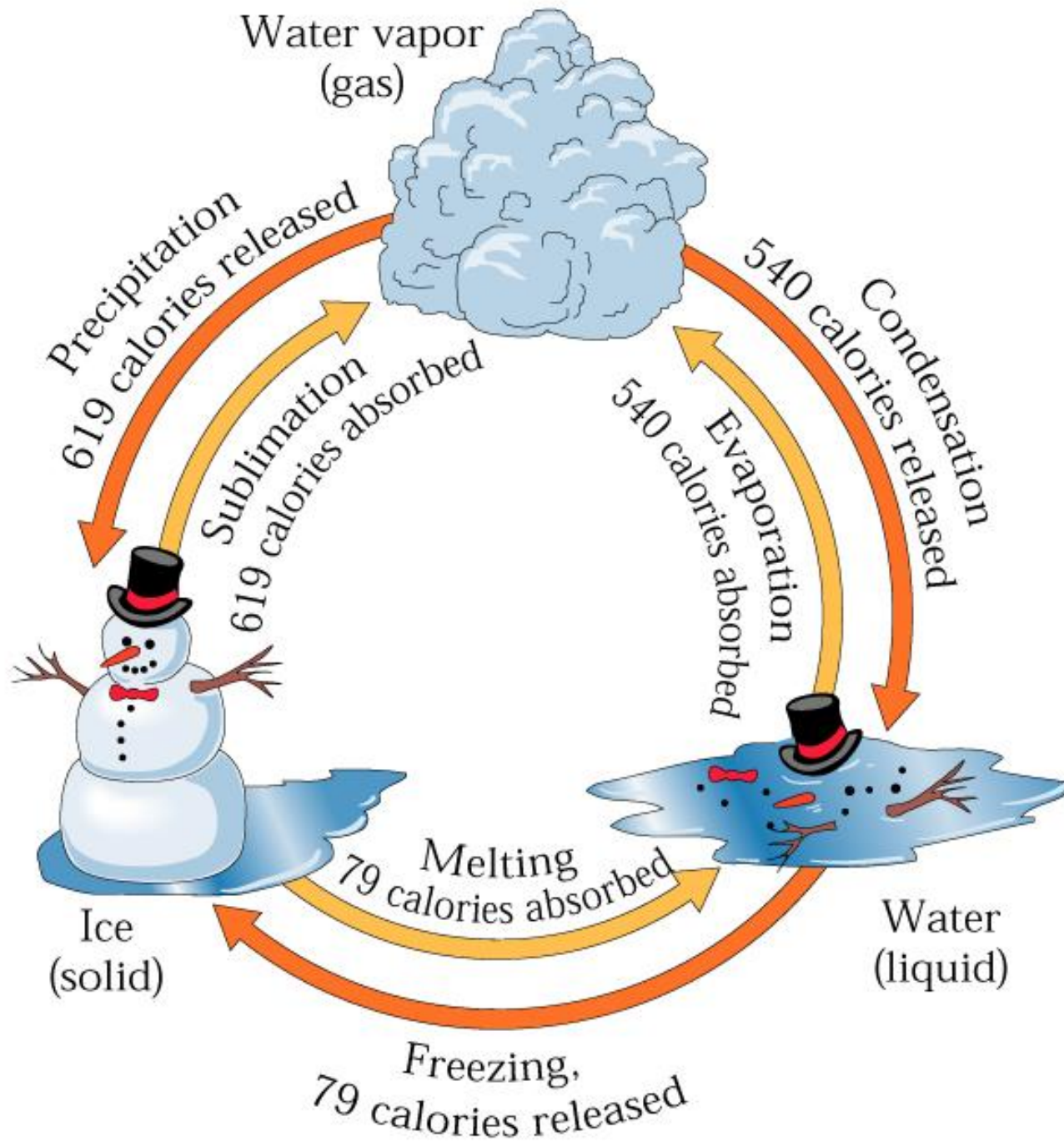
&

Intercampus of Marine Sciences Program

[http://faculty.uml.edu/David\\_Ryan/84.653](http://faculty.uml.edu/David_Ryan/84.653)

Username: chemocean

Password: letmein



**Large Quantities of Heat are Absorbed & Released During Phase Changes**

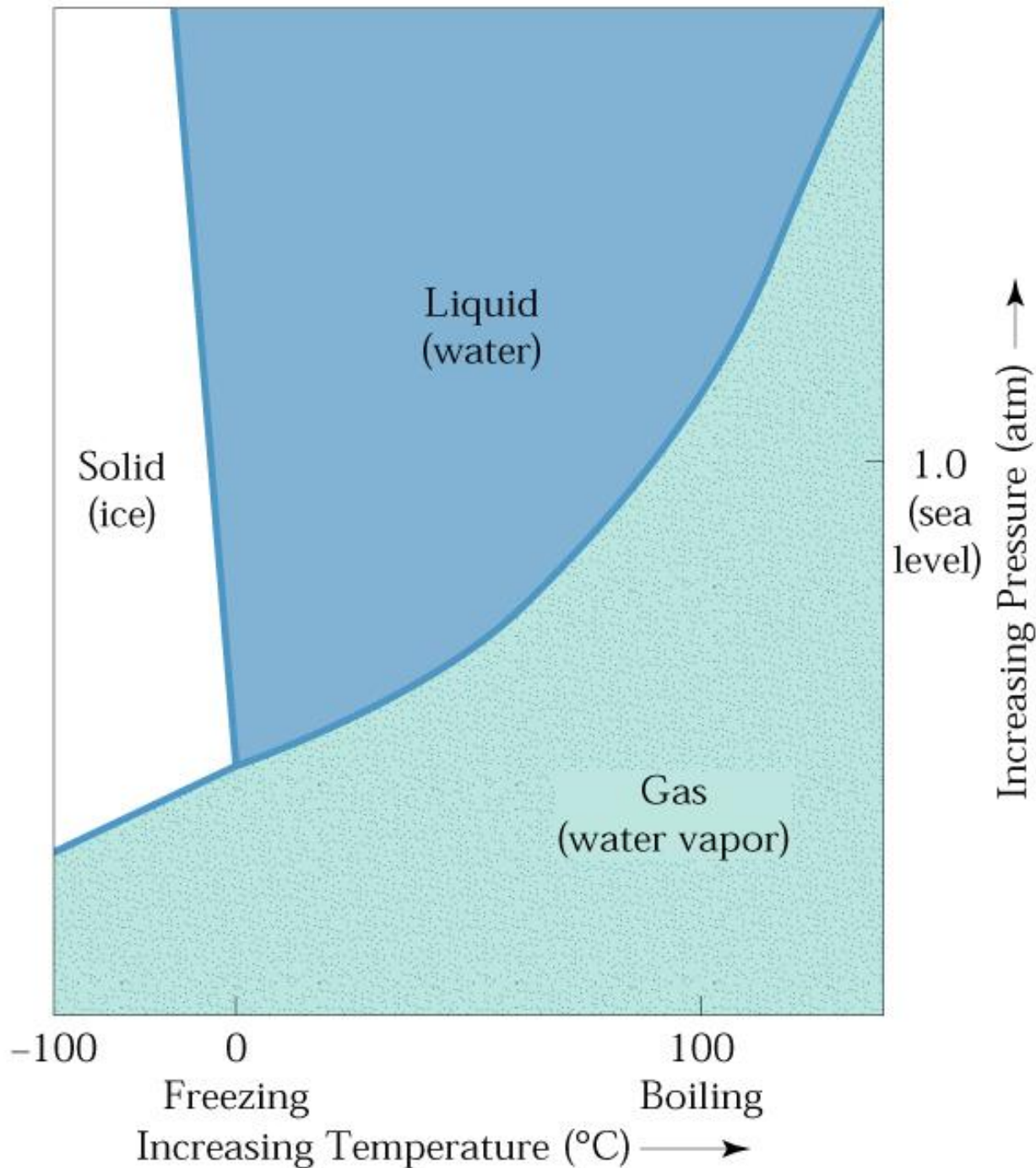
# Water Properties

## Thermal Expansion

(temperature of maximum density)

Waters with low or no salt content have  
maximum density above freezing points

Ice floats



# Simple Phase Diagram of Water

(Wiley 1999)

# Water Properties

## High Dielectric Constant

(highest of almost all substances)

Results in charge insulating power

Important in dissolution of salts

Important in hydration of ions

# Water Properties

## Relatively High Viscosity

(high for low molecular weight substance)

Important in wave and current formation

# Water Properties

## High Surface Tension

(highest of all substances)

Controls drop formation, important in waves  
and many surface properties

Important in cell physiology

Interfacial Tension  
creates appearance  
of a “skin” on surface





# Water Properties

## High Heat Conduction

(highest of all liquids)

Important for small scale heat transfer as in  
cells

# Water Properties

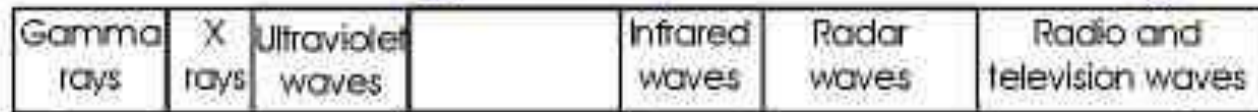
## High Transparency

(absorption of radiant energy high in IR and UV)

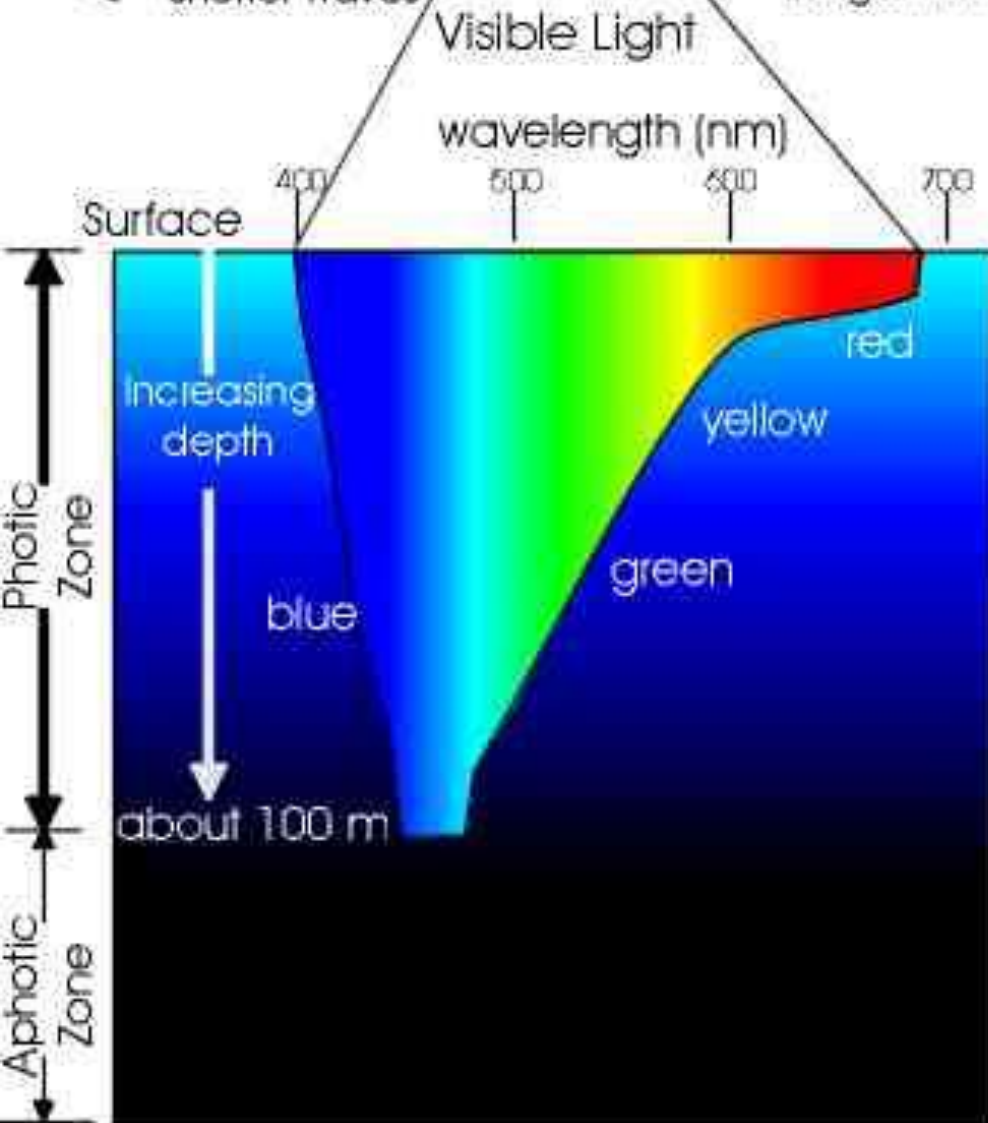
Water is colorless

Important in photosynthetic and photochemical processes

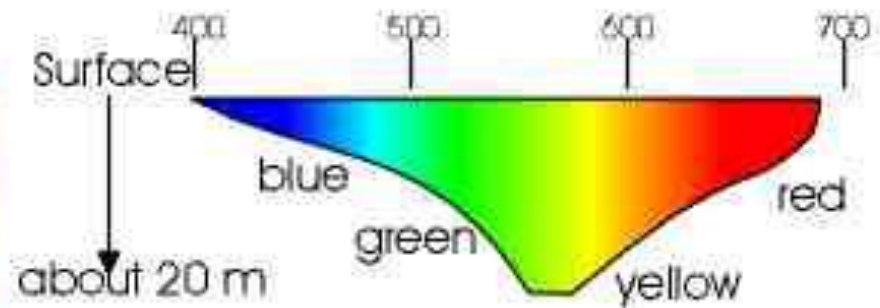
# Electromagnetic spectrum of sunlight



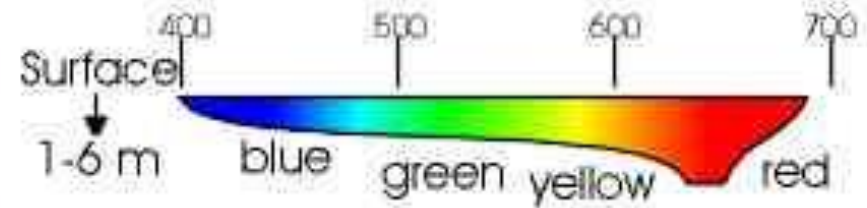
← Shorter waves      Longer waves →



Transmission of light in "pure" fresh or saltwater



Transmission of light in coastal marine water



Transmission of light in estuarine water

# Water Properties

## Low Electrolytic Dissociation

(neutral molecule containing some  $\text{OH}^-$  and  $\text{H}^+$ )

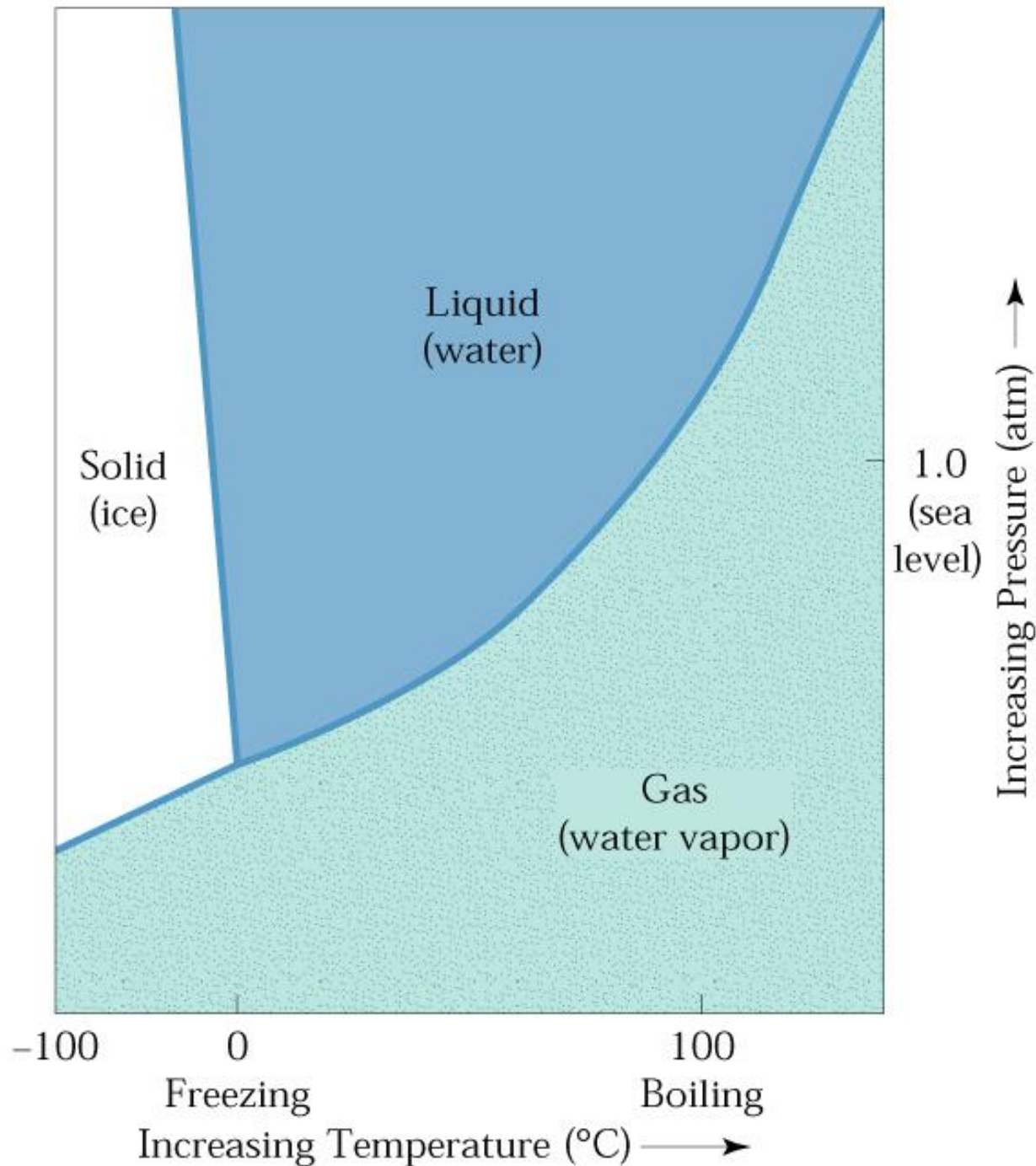
Autodissociation of water important in acid-base chemistry, many geological and biological processes

# Water Properties

## Low Compressibility

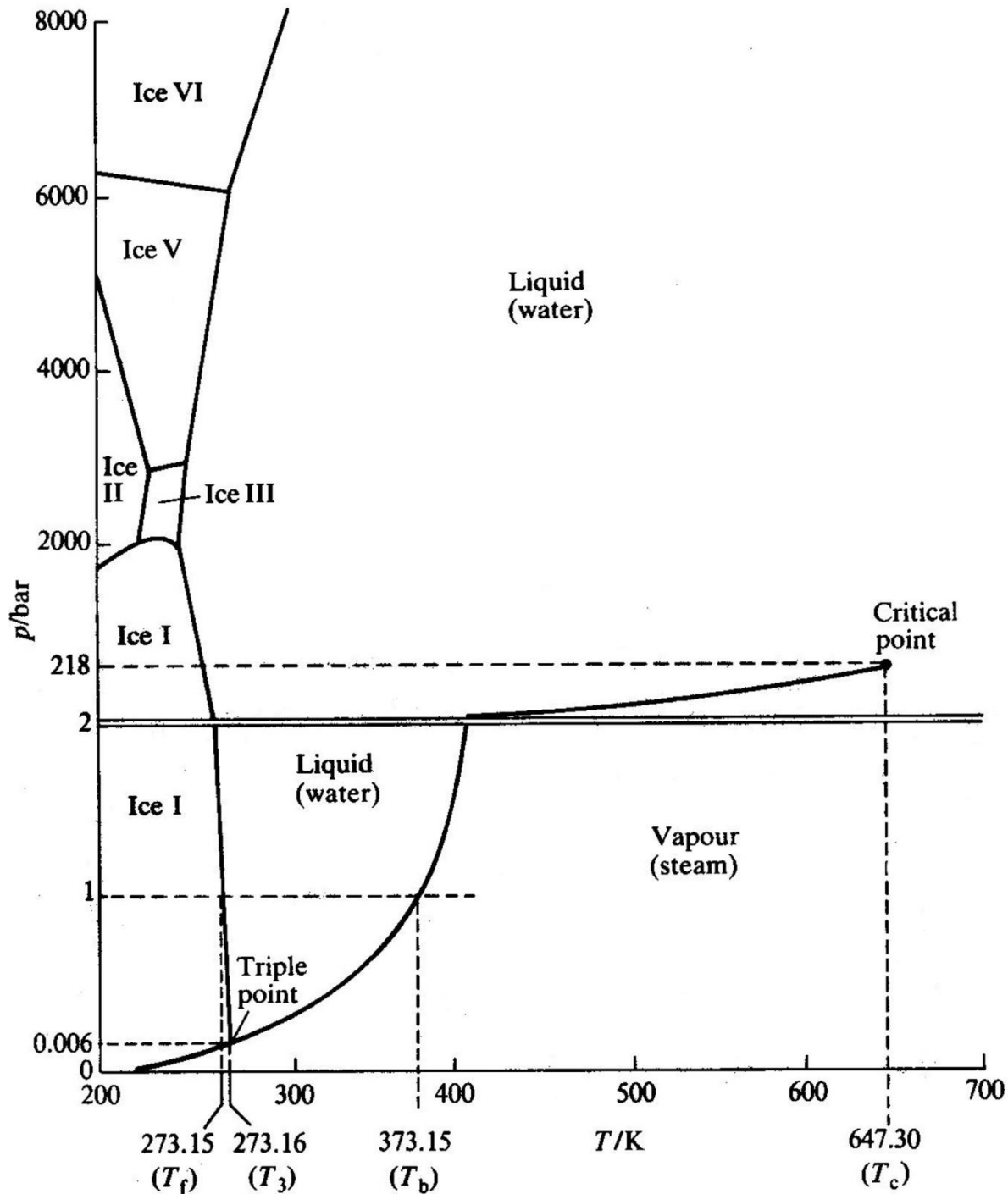
(similar to solids)

Little change in density as pressure increases  
with depth

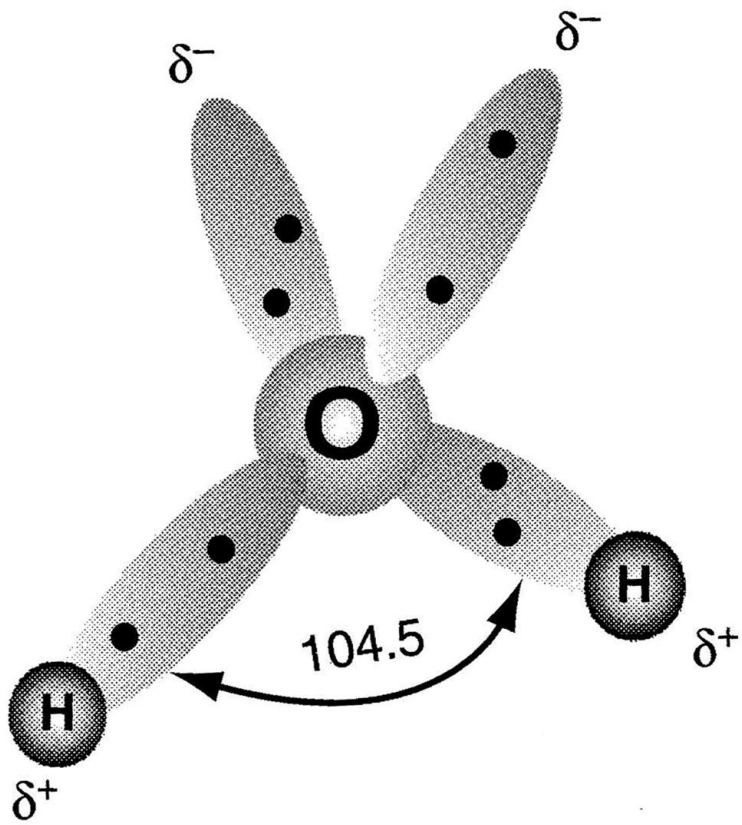


# Simple Phase Diagram of Water

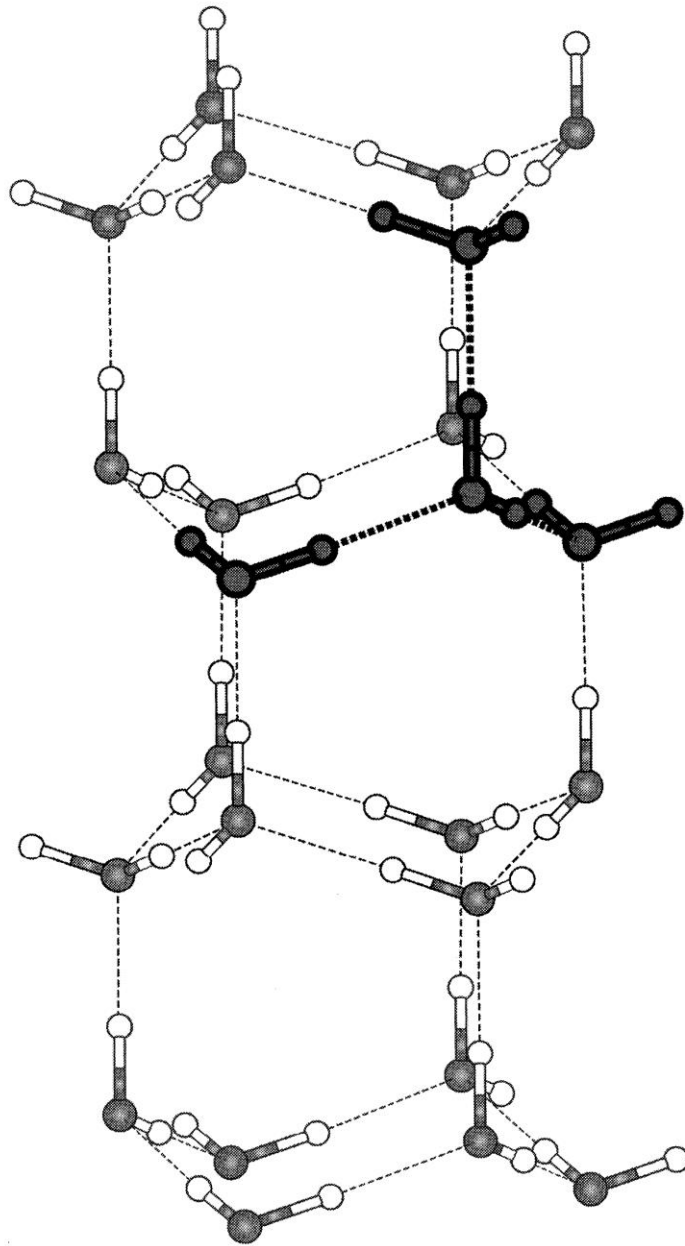
**(Wiley 1999)**



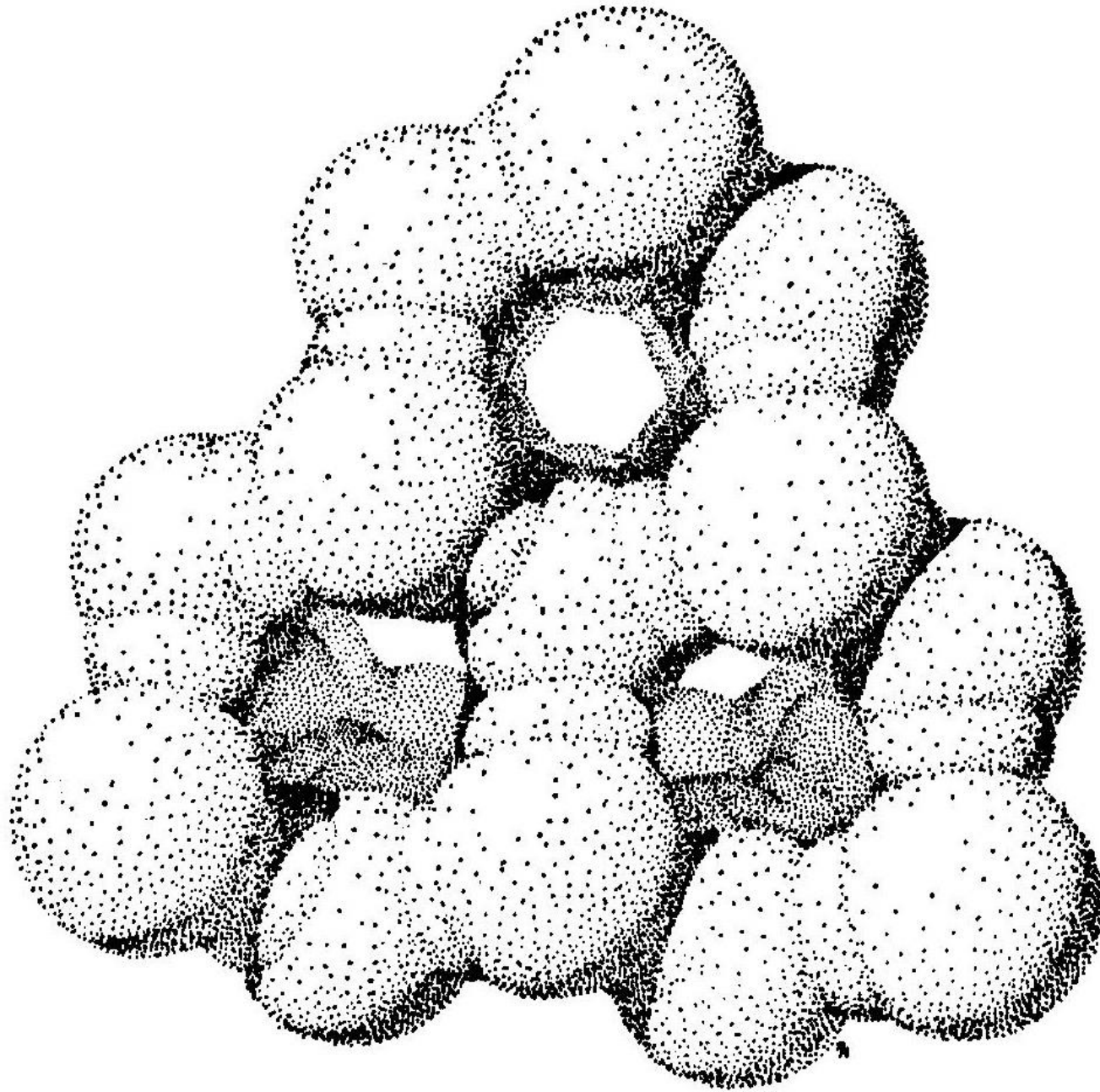
**Detailed  
Phase  
Diagram of  
Water  
Showing  
Forms of Ice  
(Atkins 1990)**







Structure of Ice 1h  
with water pentamer  
highlighted  
(Emerson & Hedges  
Fig 3.4, page 67)

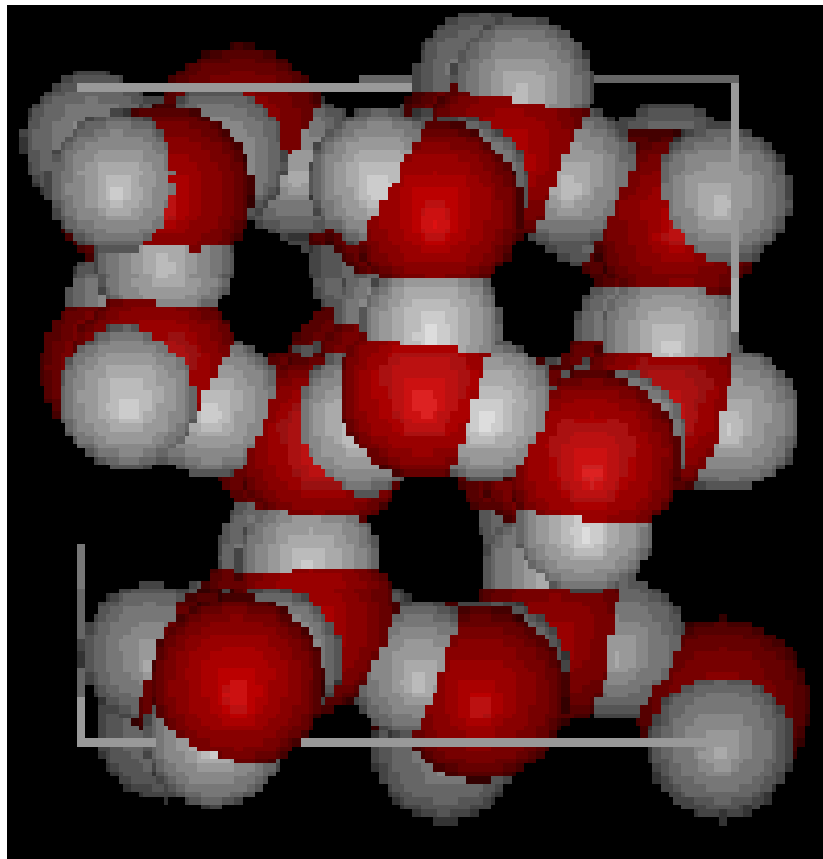


**Structure  
of Ice 1h,  
Hexagonal  
with Space  
Giving Low  
Density**

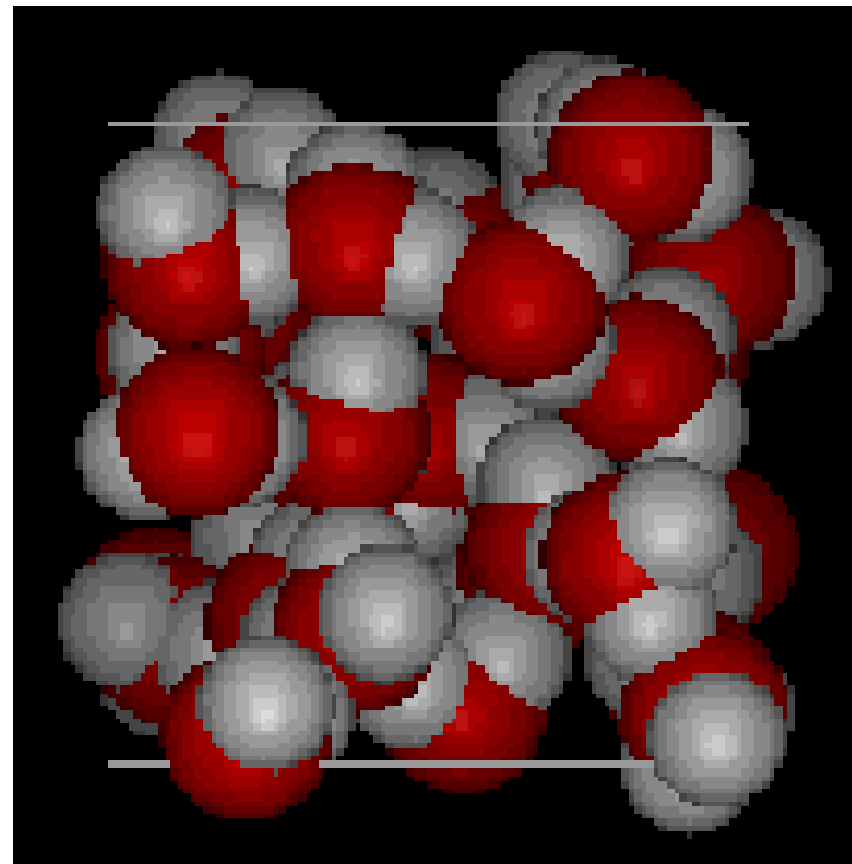
**(Pilson 1998)**

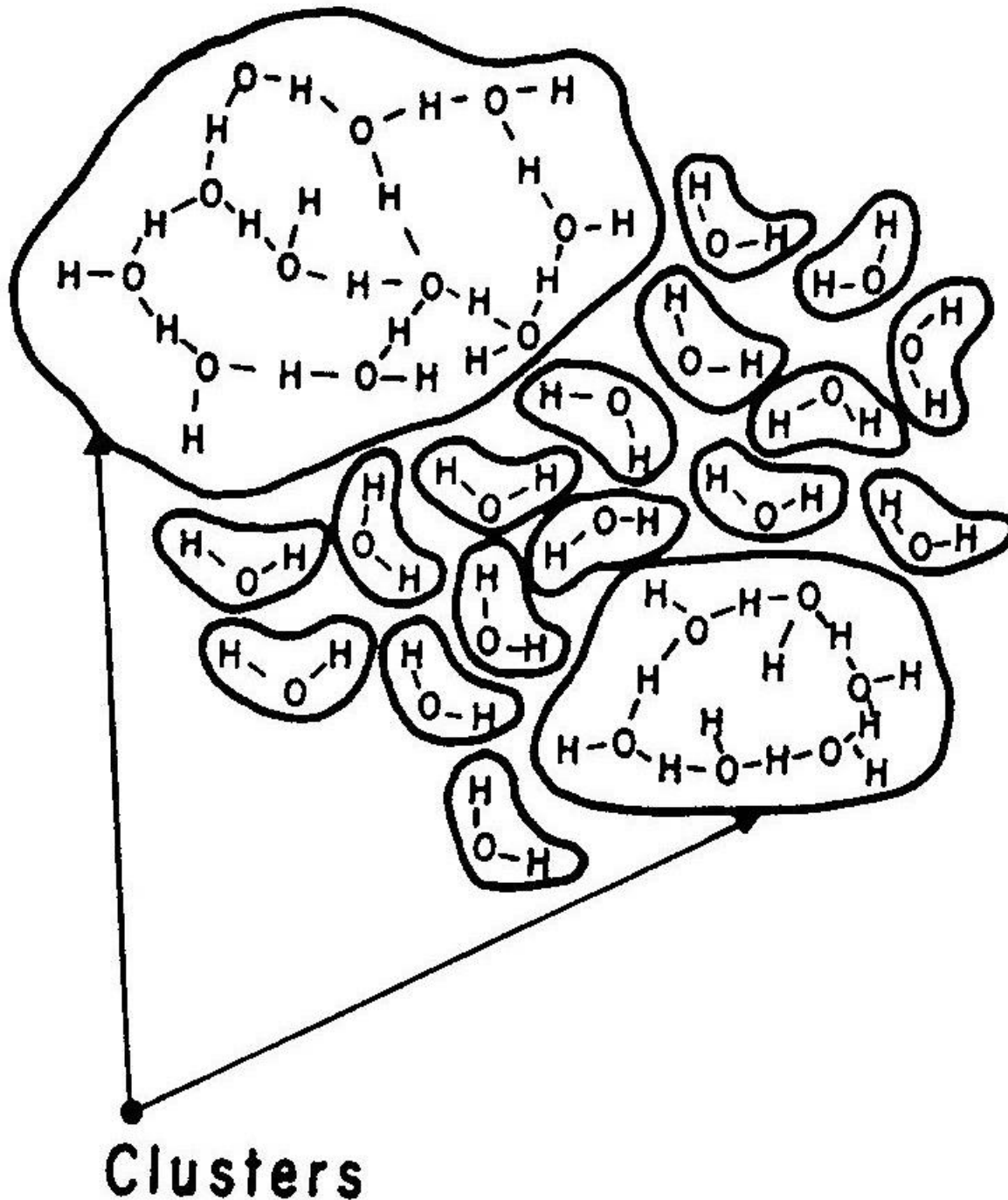
# Comparison of Ice and Liquid Water Structures (NYU-SVL)

**Ice 1h**



**Liquid Water**





**Water  
Clusters  
Dynamically  
Form, Break  
and Re-form**

**(Millero 2006)**

# Structure or Association of Water Molecules Versus Temperature and Affect on Density (Libes 1992)

