

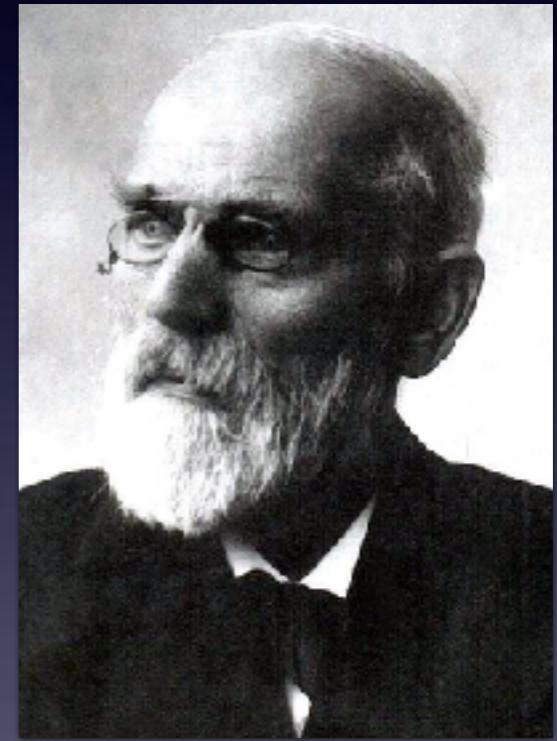
Dailies

Exam 3

Previously in Molecularity...

Intermolecular forces in ~order of decreasing strength...

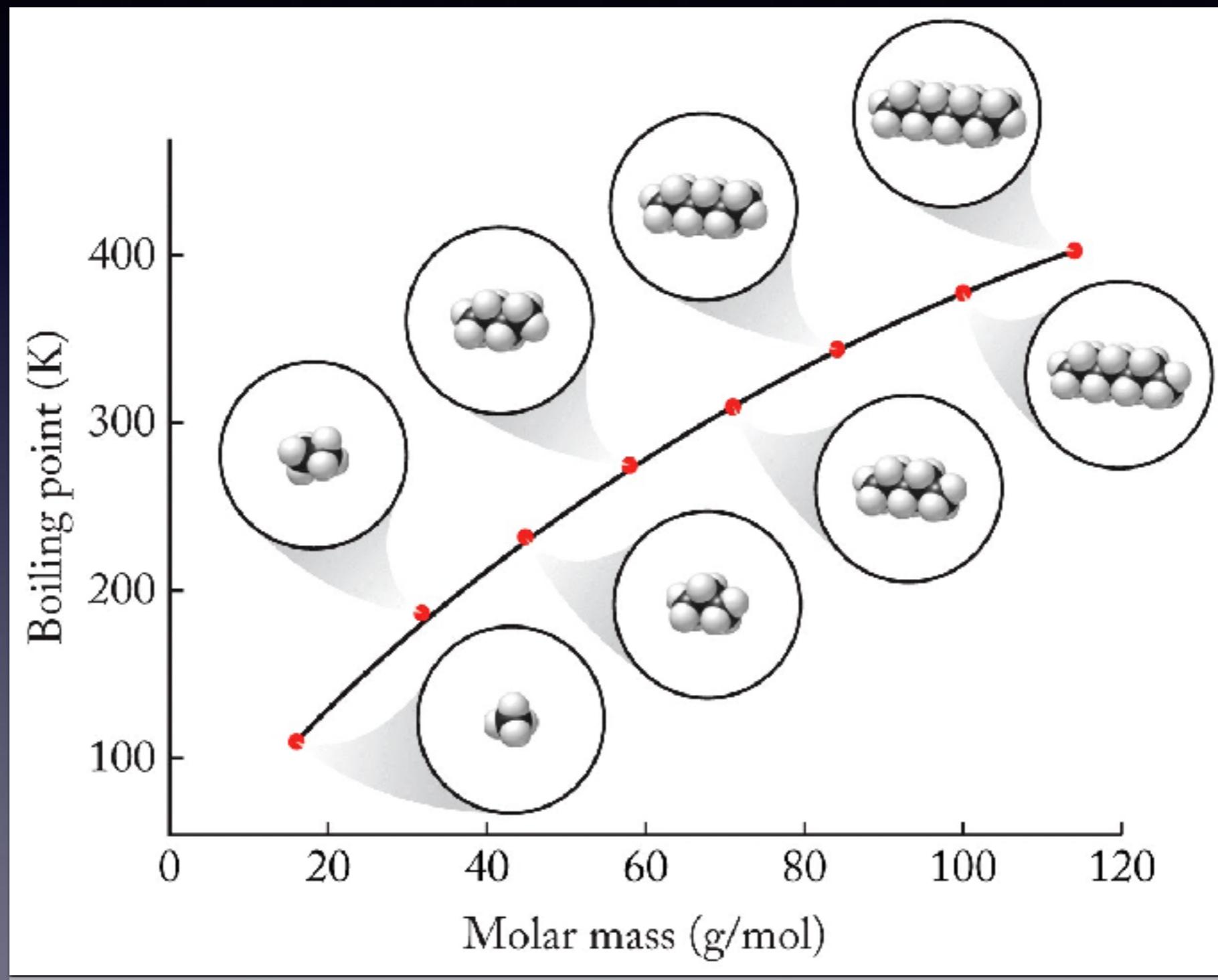
- ... between two ions
- ... between ions and a permanent dipole
- ... between ions and *induced* dipoles
- ... hydrogen bonds
- ... between two permanent dipoles
(Willem Hendrik Keesom)
- ... between a permanent dipole and an *induced* dipole (Peter Debye)
- ... between a fluctuating dipole and an *induced* dipole (Fritz London)



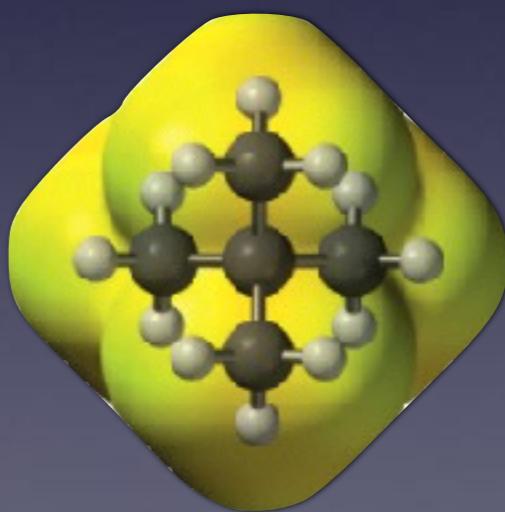
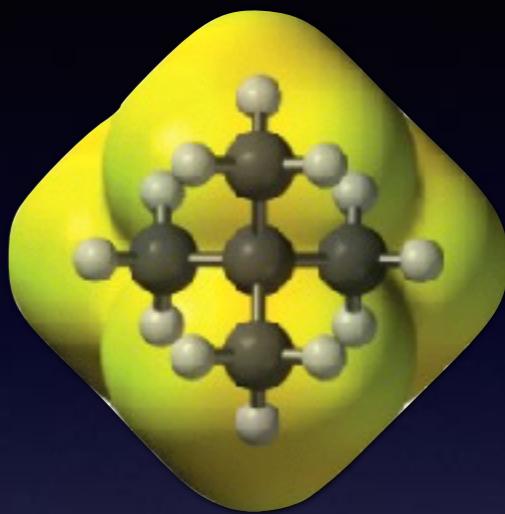
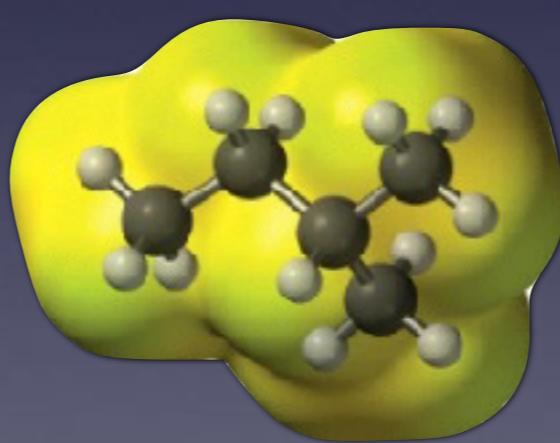
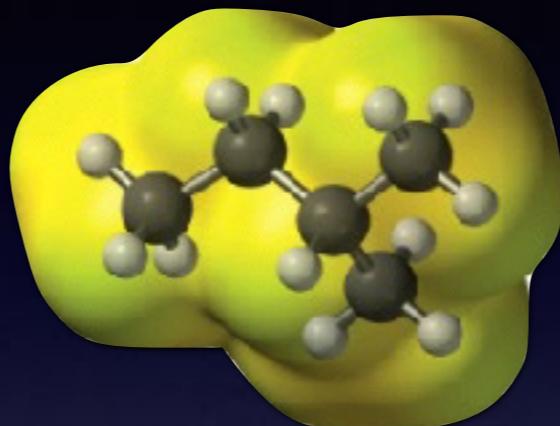
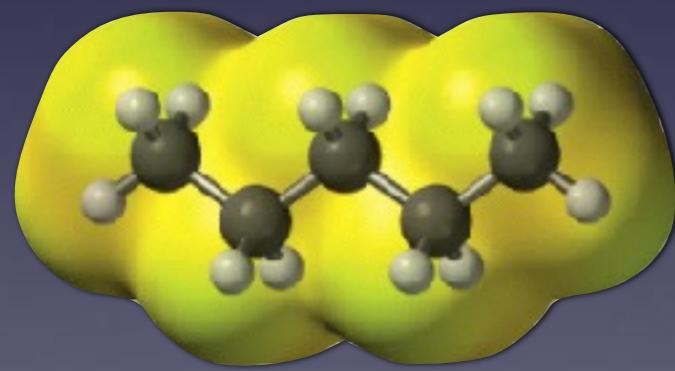
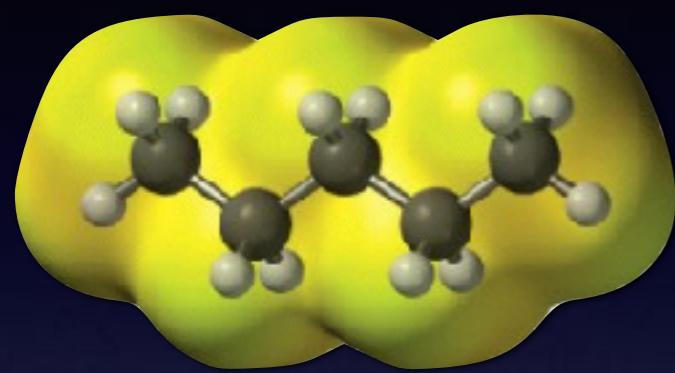
Johannes van der Waals
en.wikipedia.org

Johannes_Diderik_van_der_Waals.jpg

Boiling points increase with mass



Boiling points depend on shape



GKF 6.2

Among isomers of the same mass and formula, longer chains have higher T_{boil} than branched compounds

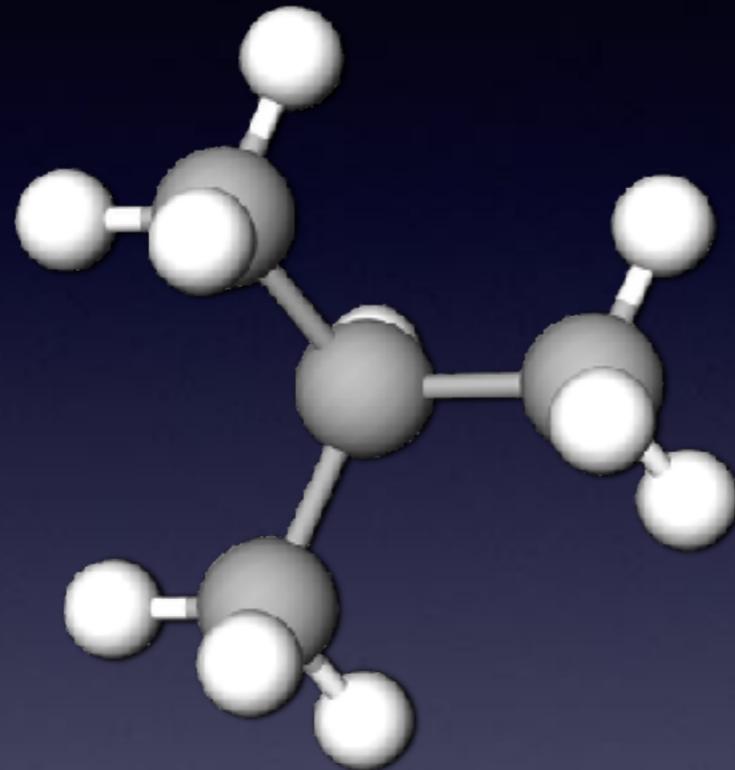
A photograph of a fork standing upright in a field of lavender. The fork's tines are pointing downwards and its handle upwards. In the background, there is a paved road leading towards a line of trees under a clear sky.

Where are we going today?

Ch1010-C17-C02 Lecture 24

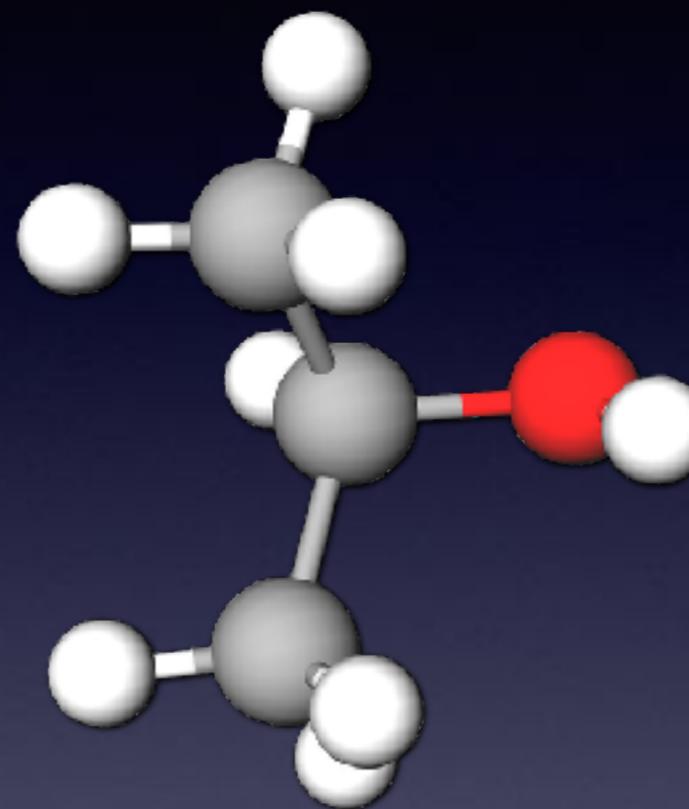
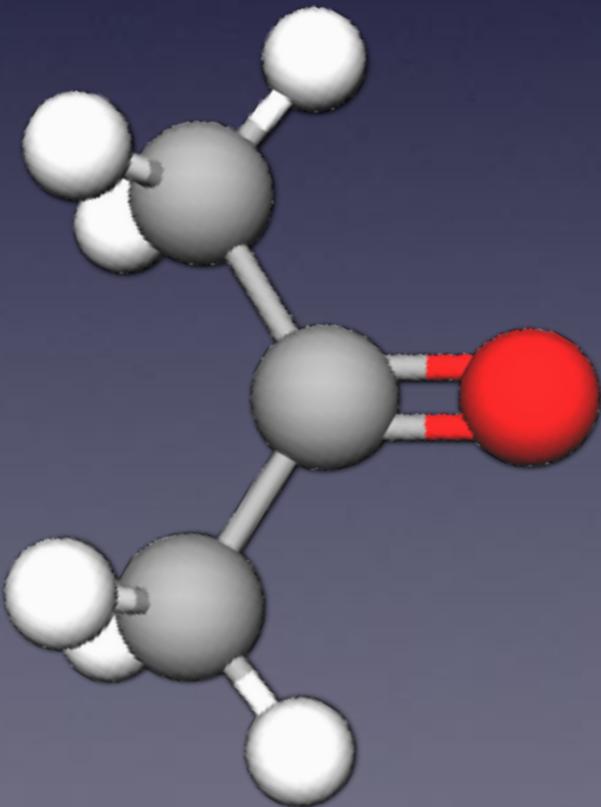
- §6.2 Polar interactions
- §6.3 Trends in solubility

Predict the boiling points in...



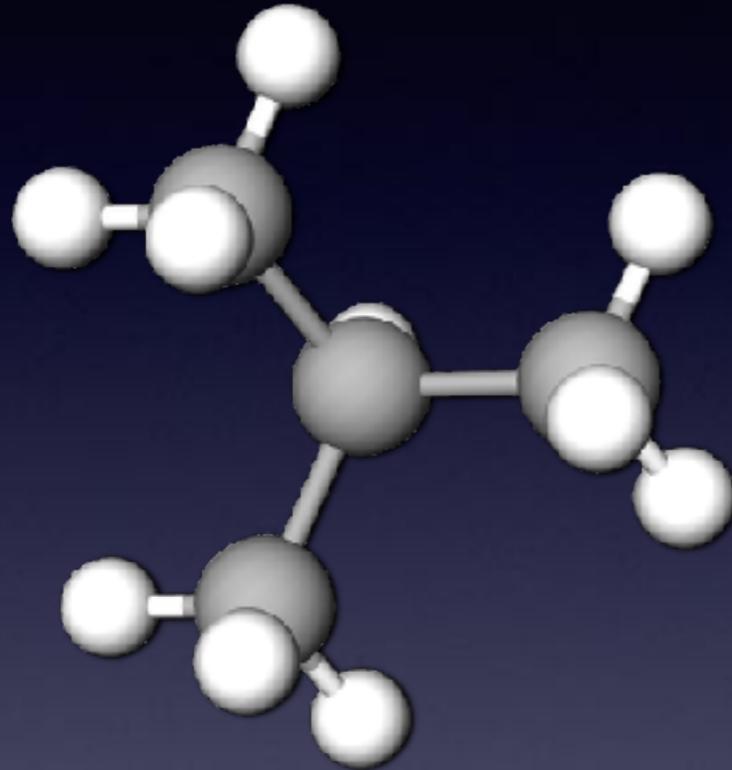
2-methyl-propane
(isobutane)

2-propanone
(acetone)



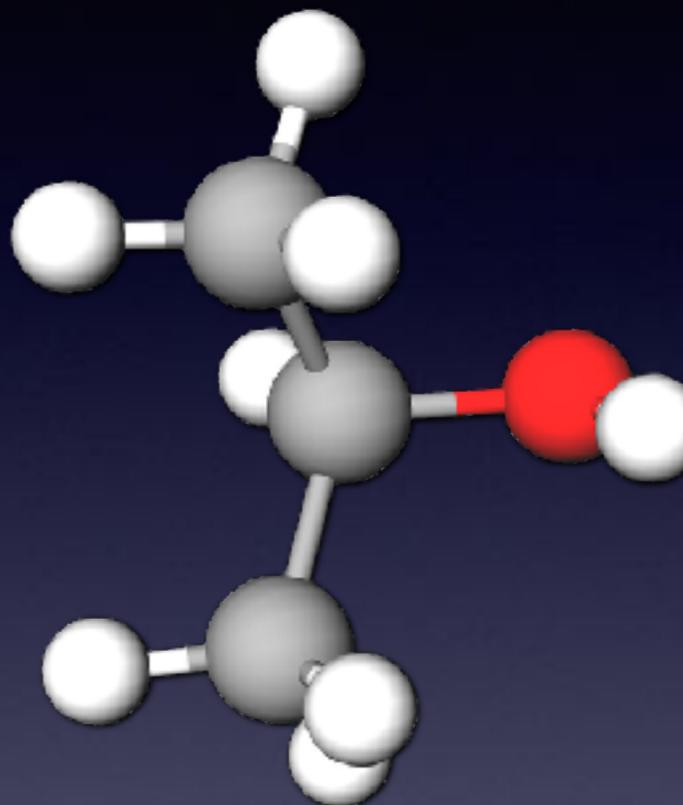
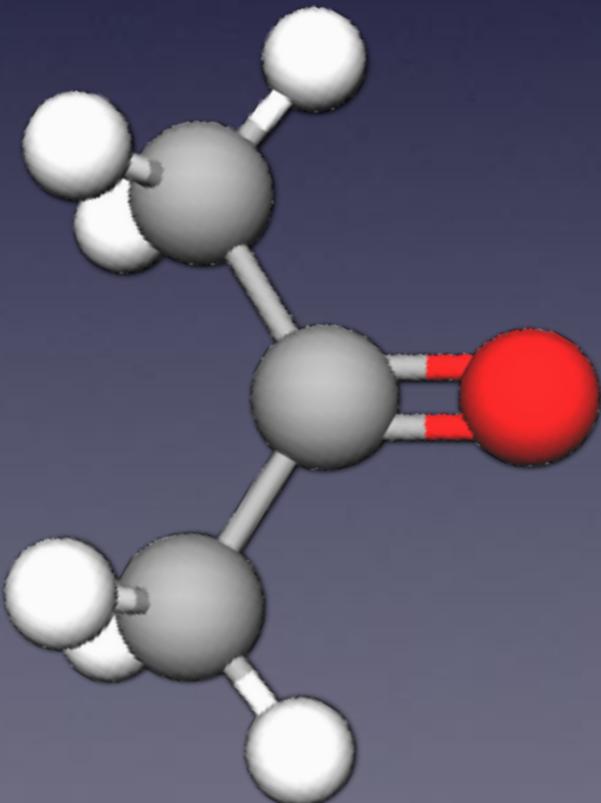
2-propanol
(isopropyl
alcohol)

Predict the boiling points in...



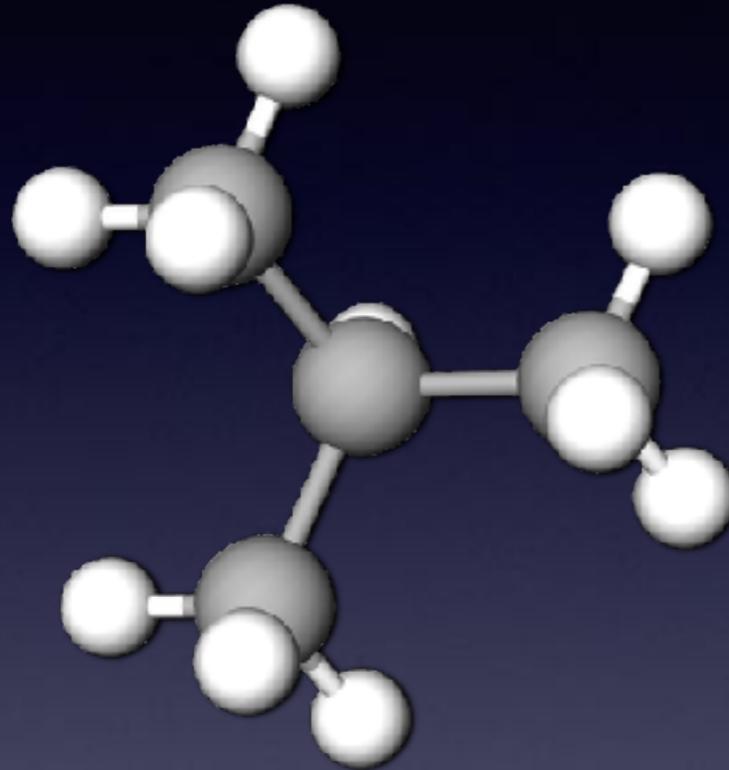
2-methyl-propane
(isobutane)

56 °C
2-propanone
(acetone)



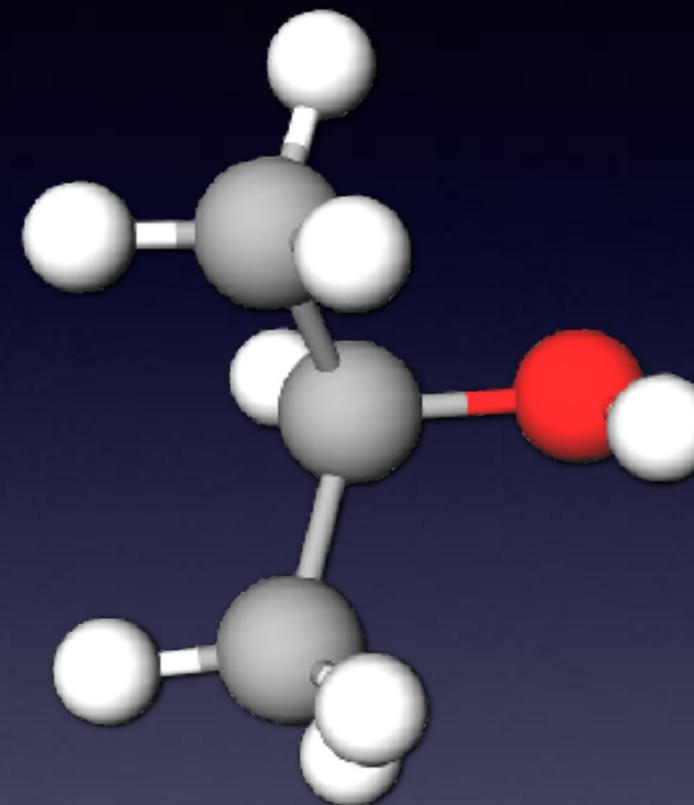
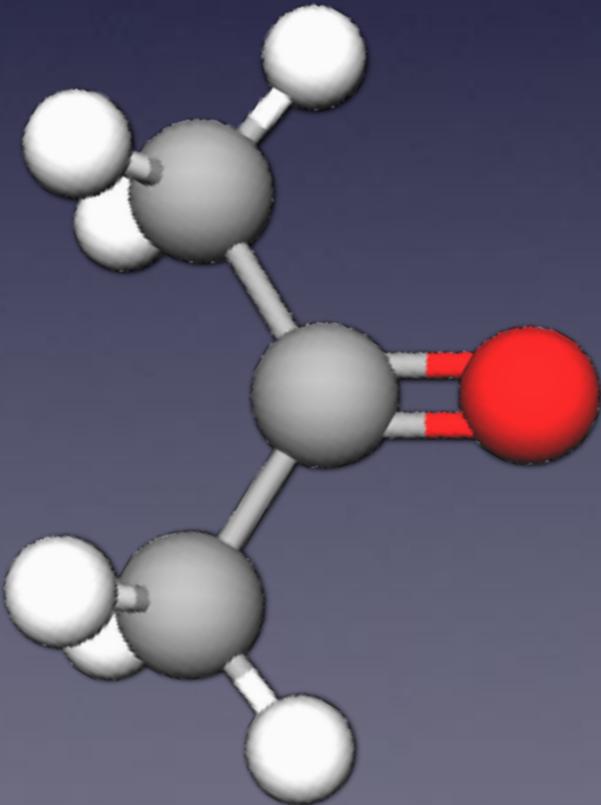
2-propanol
(isopropyl
alcohol)

Predict the boiling points in...



2-methyl-propane
(isobutane)

-12 °C



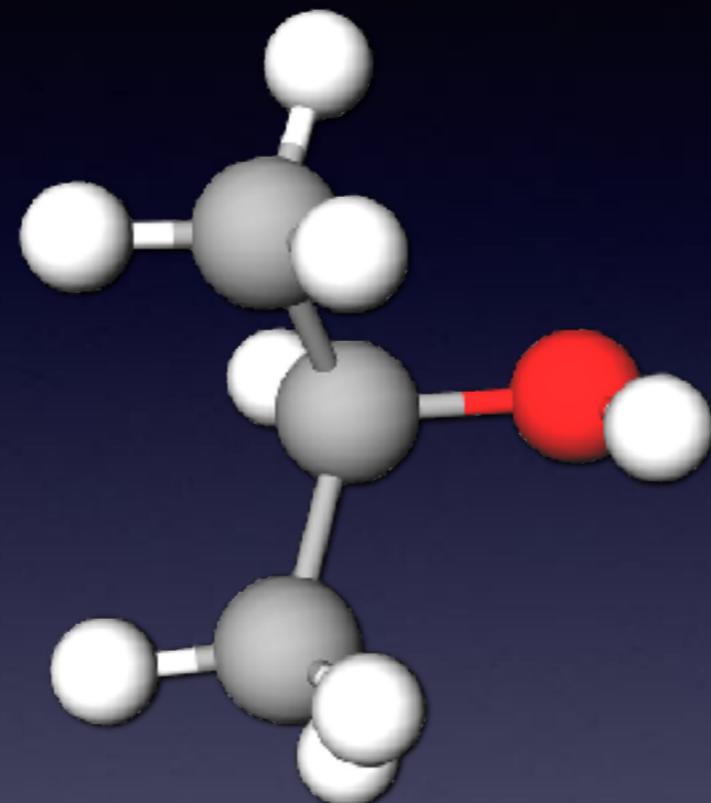
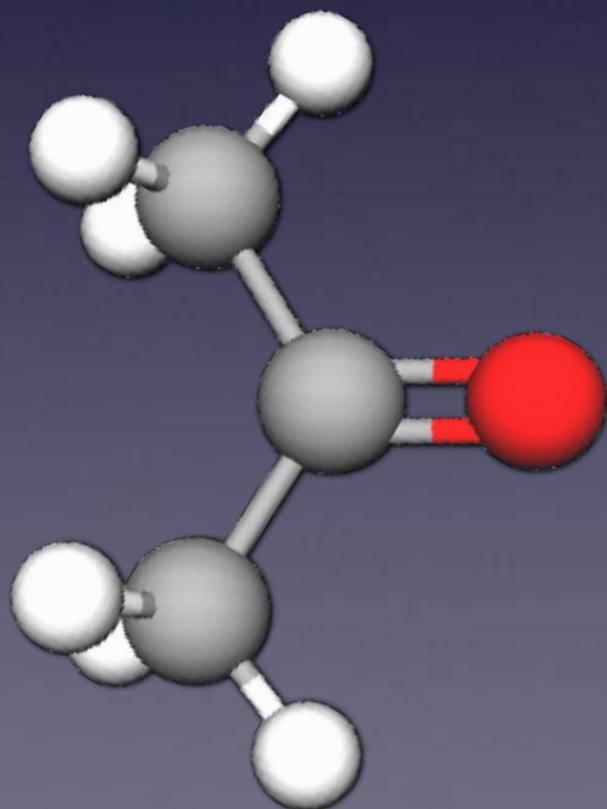
2-propanol
(isopropyl
alcohol)

86 °C

Predict the boiling points in...

56 °C

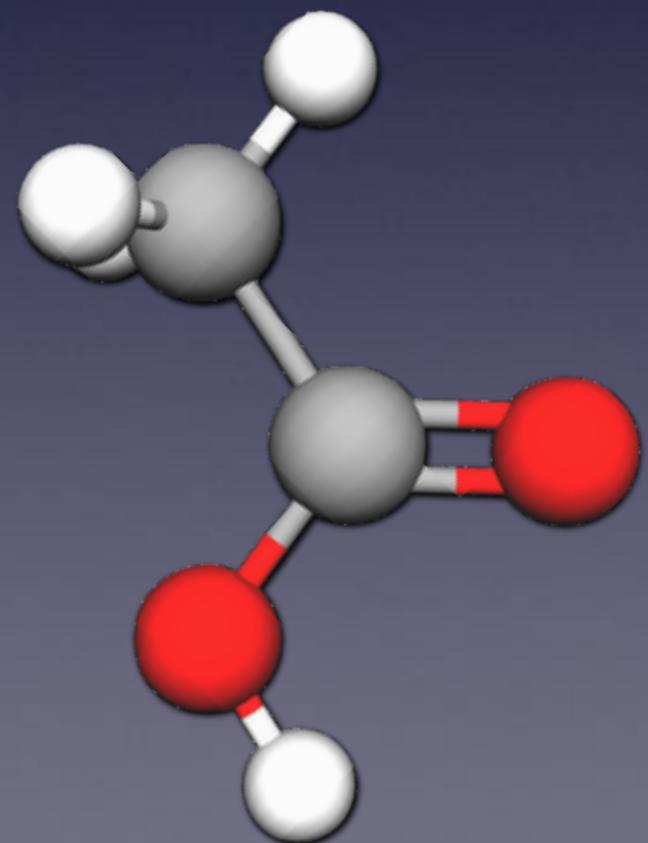
2-propanone
(acetone)



2-propanol
(isopropyl
alcohol)

86 °C

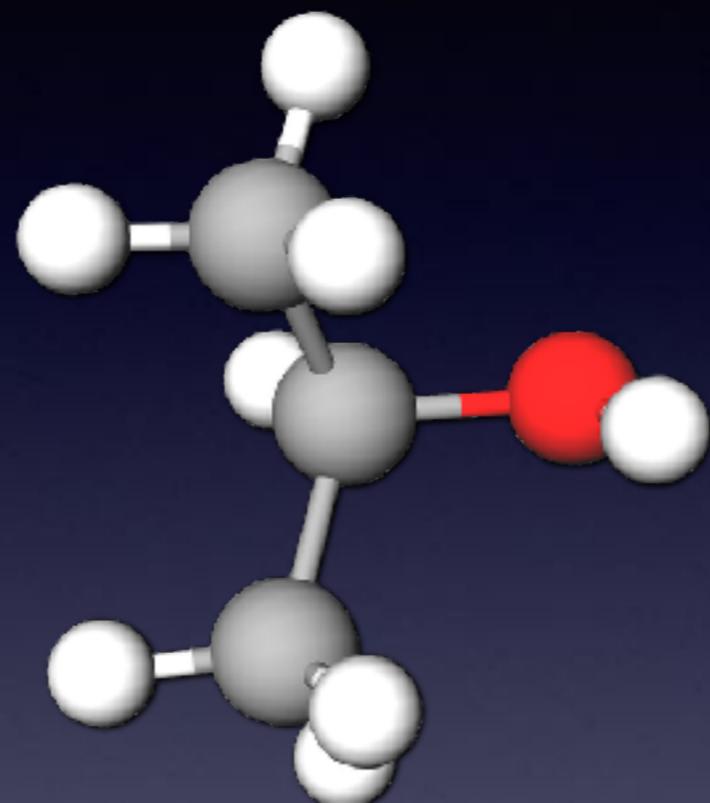
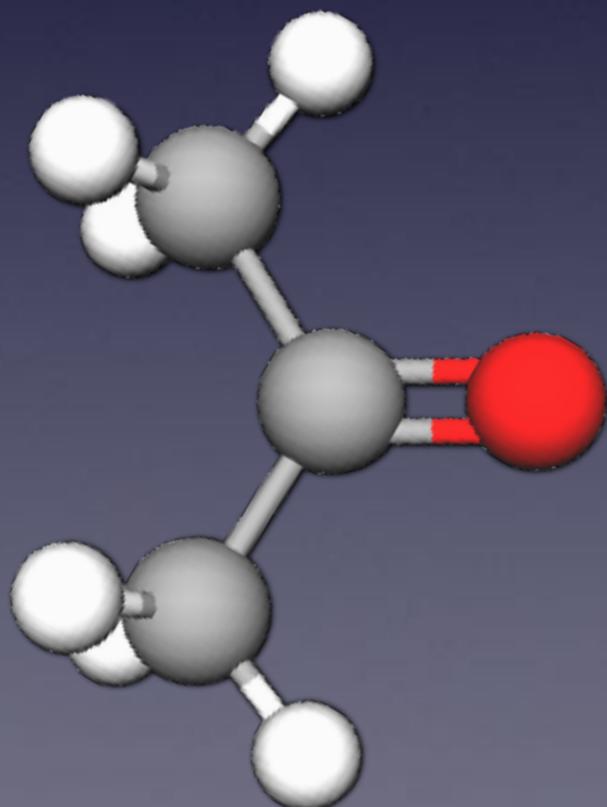
2-ethanoic acid
(acetic acid)



Predict the boiling points in...

56 °C

2-propanone
(acetone)

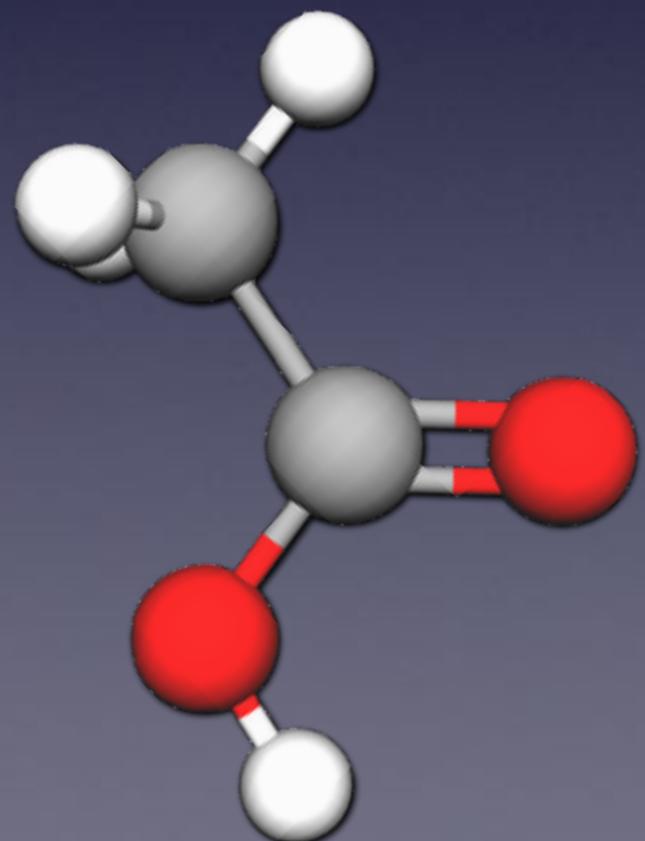


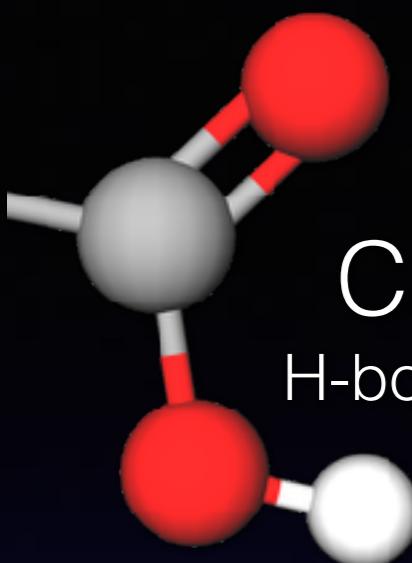
2-propanol
(isopropyl
alcohol)

86 °C

115 °C

2-ethanoic acid
(acetic acid)





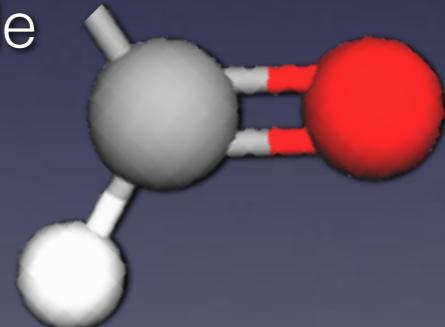
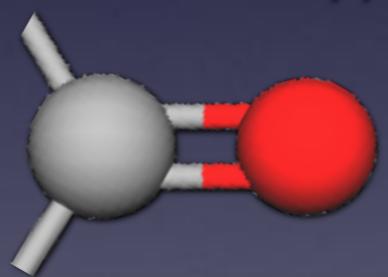
Carboxylic acids
H-bond acceptors and donors

Trends in $T_{\text{boil}} \dots$

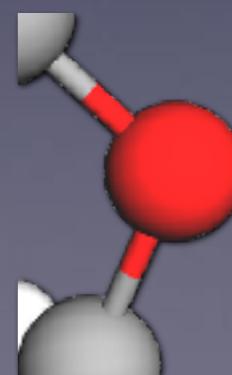
Alcohols
H-bond acceptors and donors



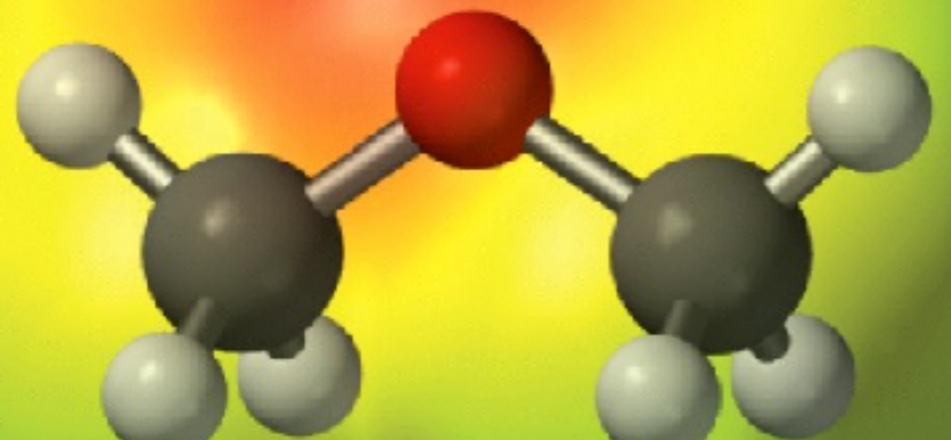
Ketones and aldehydes
H-bond acceptors
Strong dipole



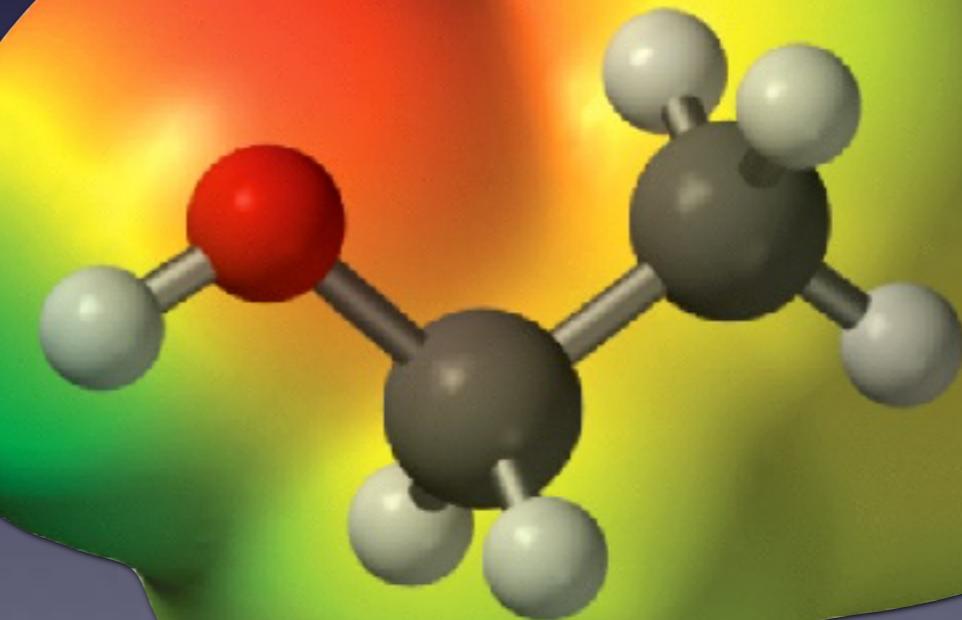
Ethers
H-bond acceptors
Weak dipole



Trends in $T_{\text{boil}} \dots$

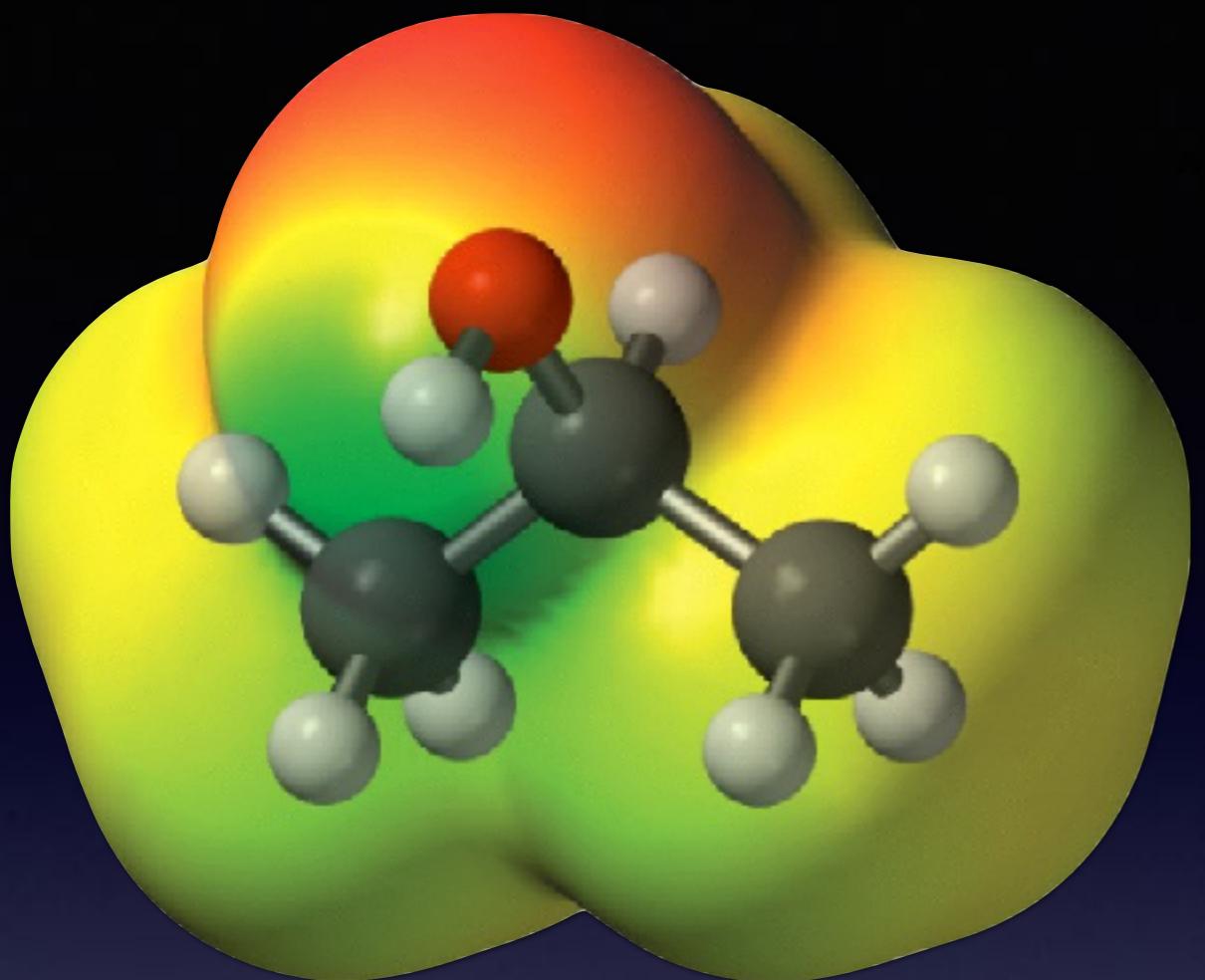


Dimethyl ether
 $T_{\text{boil}} = -25^\circ\text{C}$

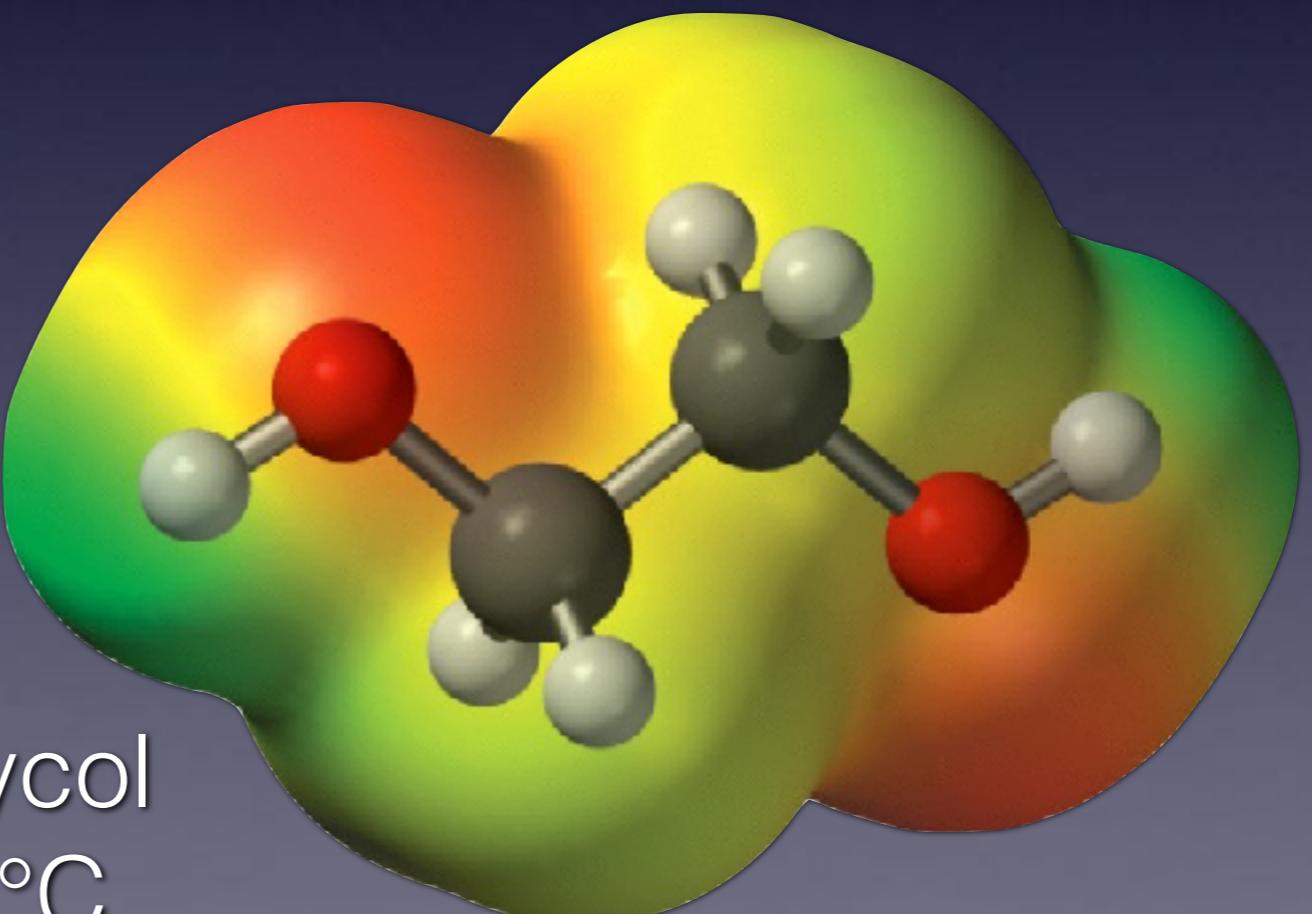


Ethanol
 $T_{\text{boil}} = 78^\circ\text{C}$

Trends in $T_{\text{boil}} \dots$

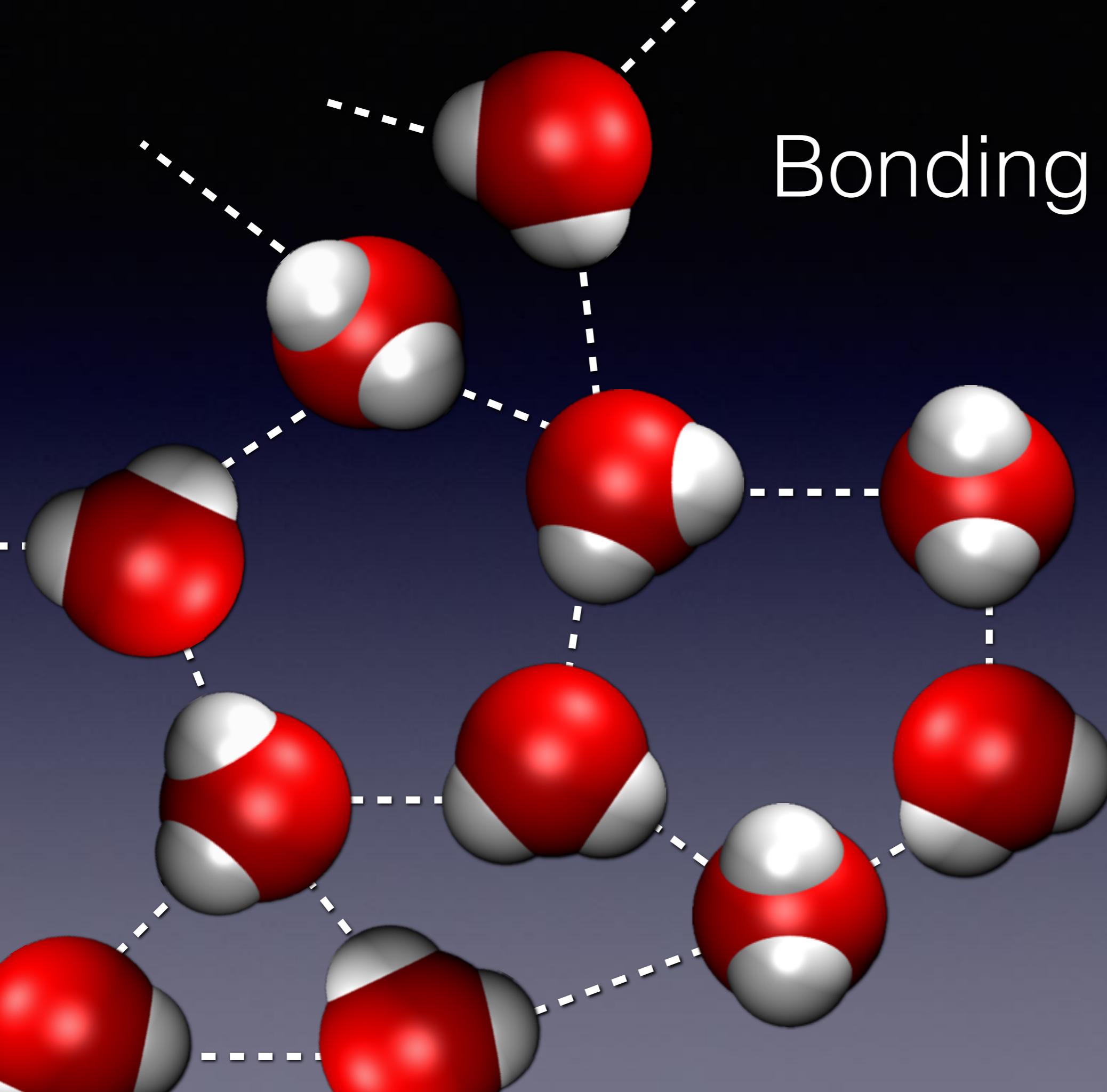


Isopropyl alcohol
 $T_{\text{boil}} = 82 \text{ }^{\circ}\text{C}$

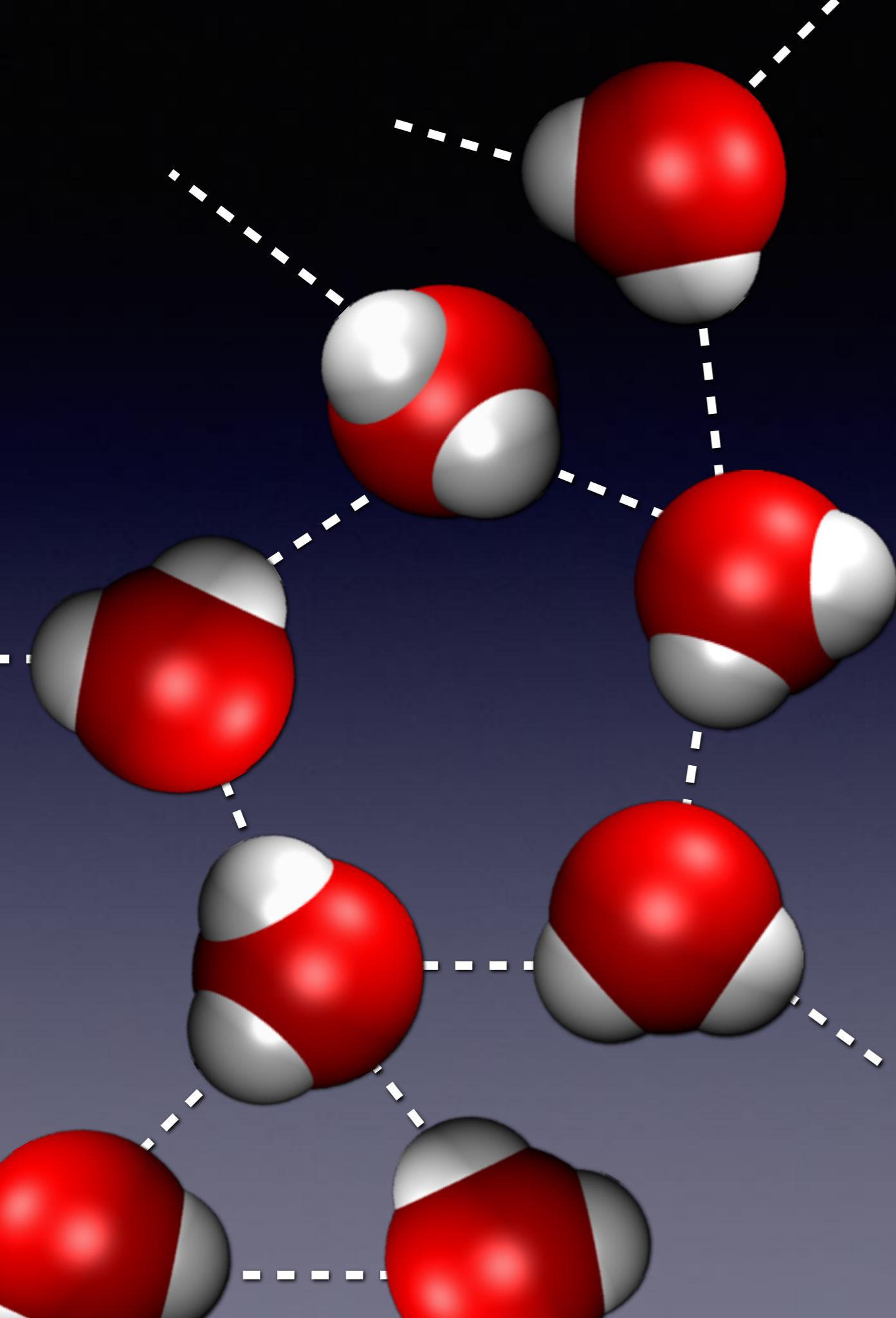


Ethylene glycol
 $T_{\text{boil}} = 196 \text{ }^{\circ}\text{C}$

Bonding in water



Bonding in water



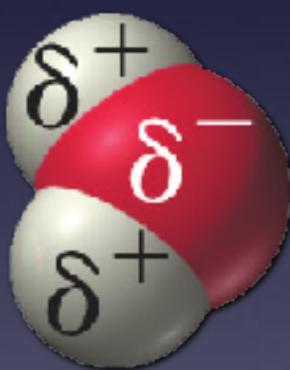
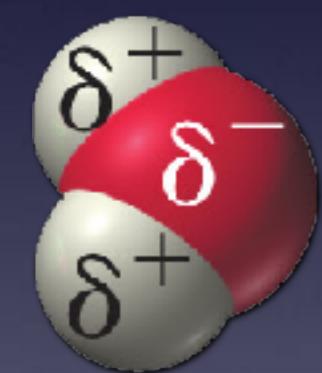
- Called **hydrogen bonds**.
- Species that can participate in this bonding network will be **solvated**.
- Ionic species frequently **dissociate** (dissolve) to increase bonding.
- Not all ionic species dissolve.
- Molecular species dissolve based on polarity

Solubility of ionic compounds

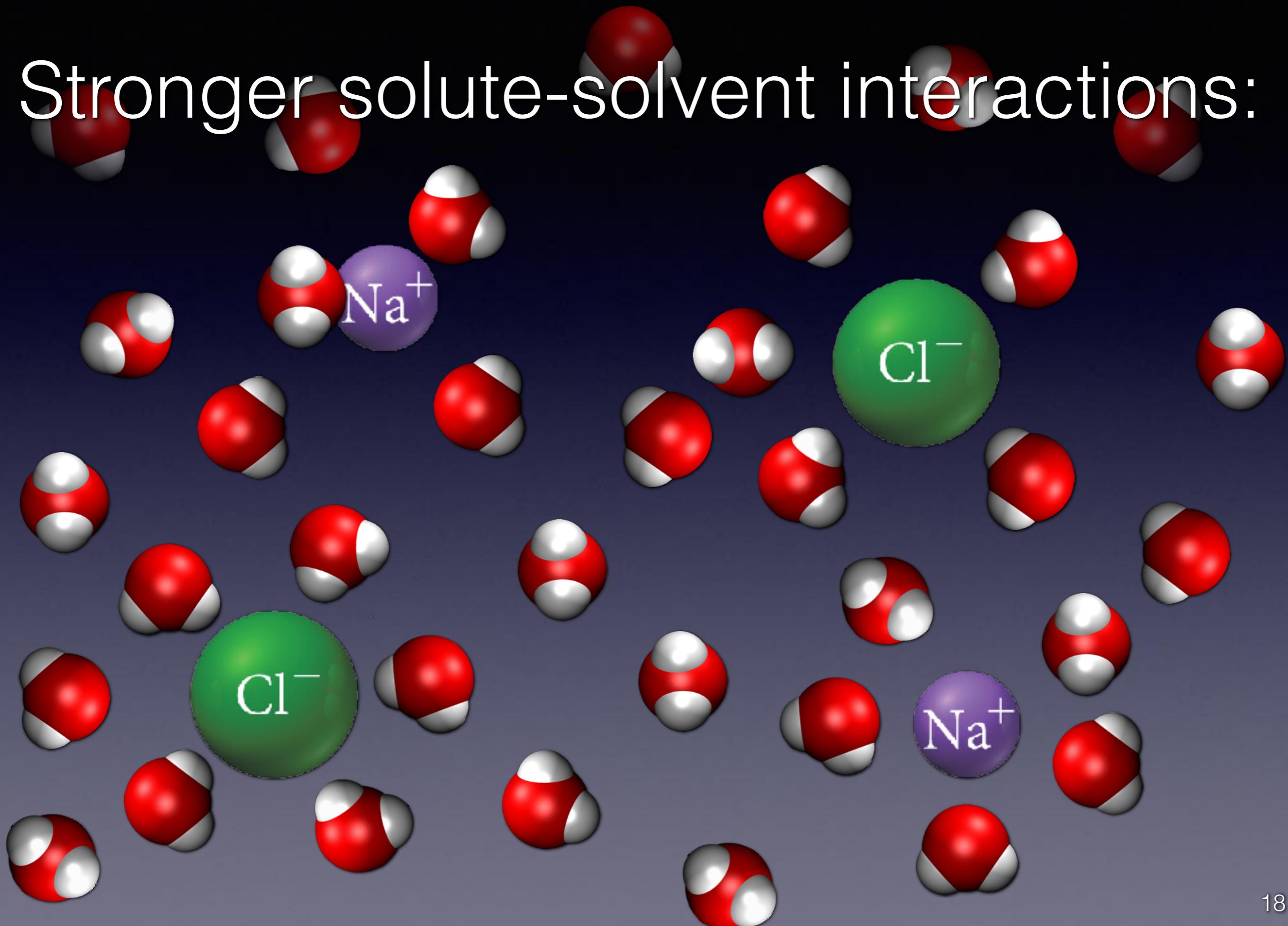
solute-solvent
interaction

solute-solvent
interaction

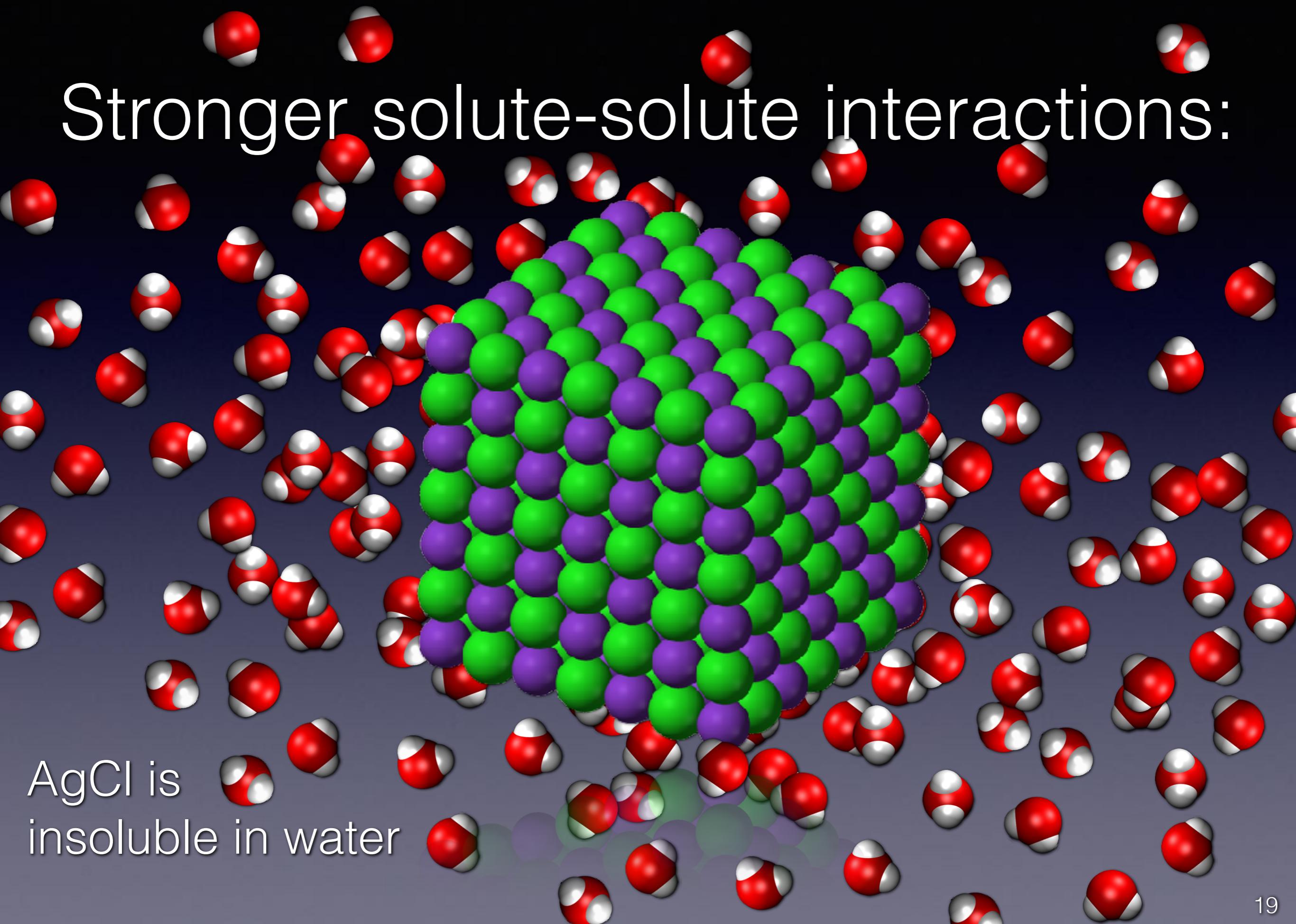
solute-solute
interaction



Stronger solute-solvent interactions:

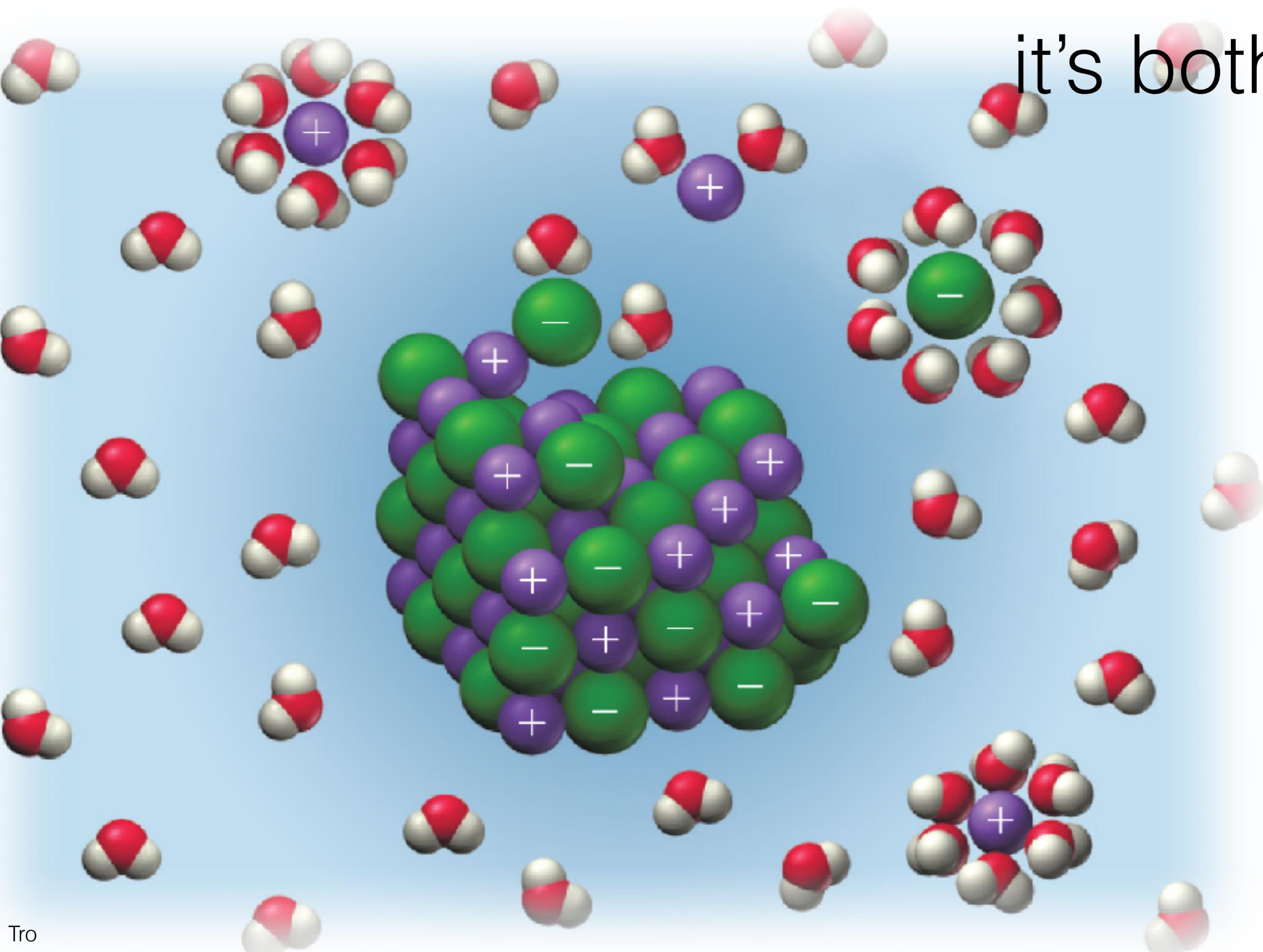


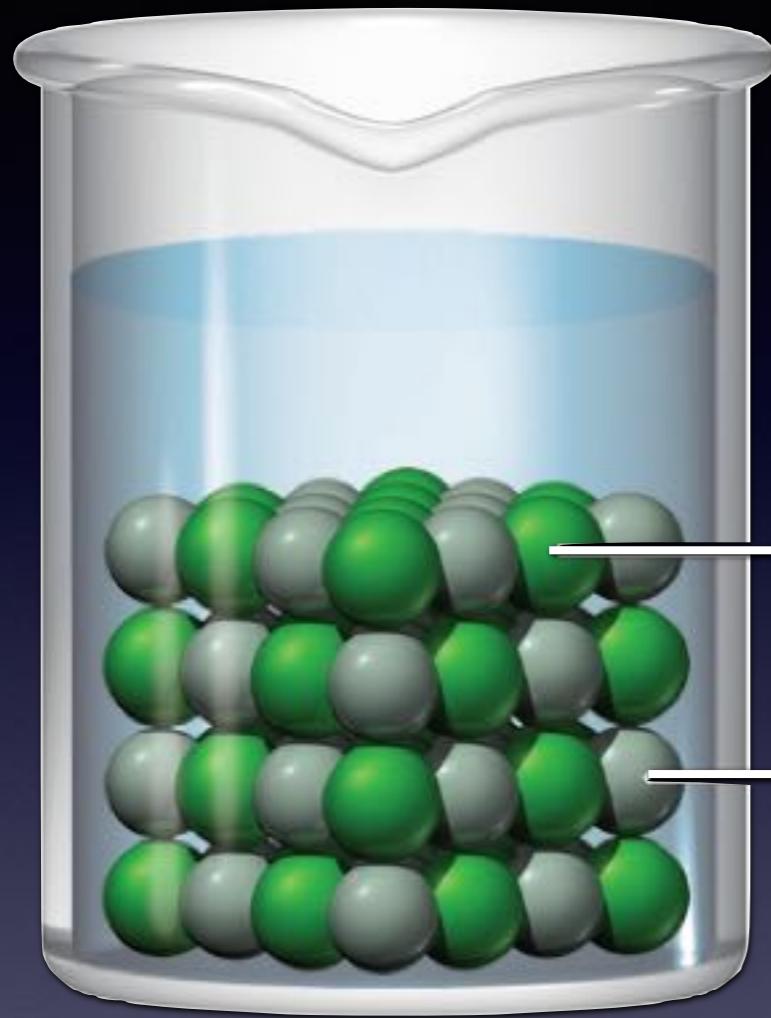
Stronger solute-solute interactions:



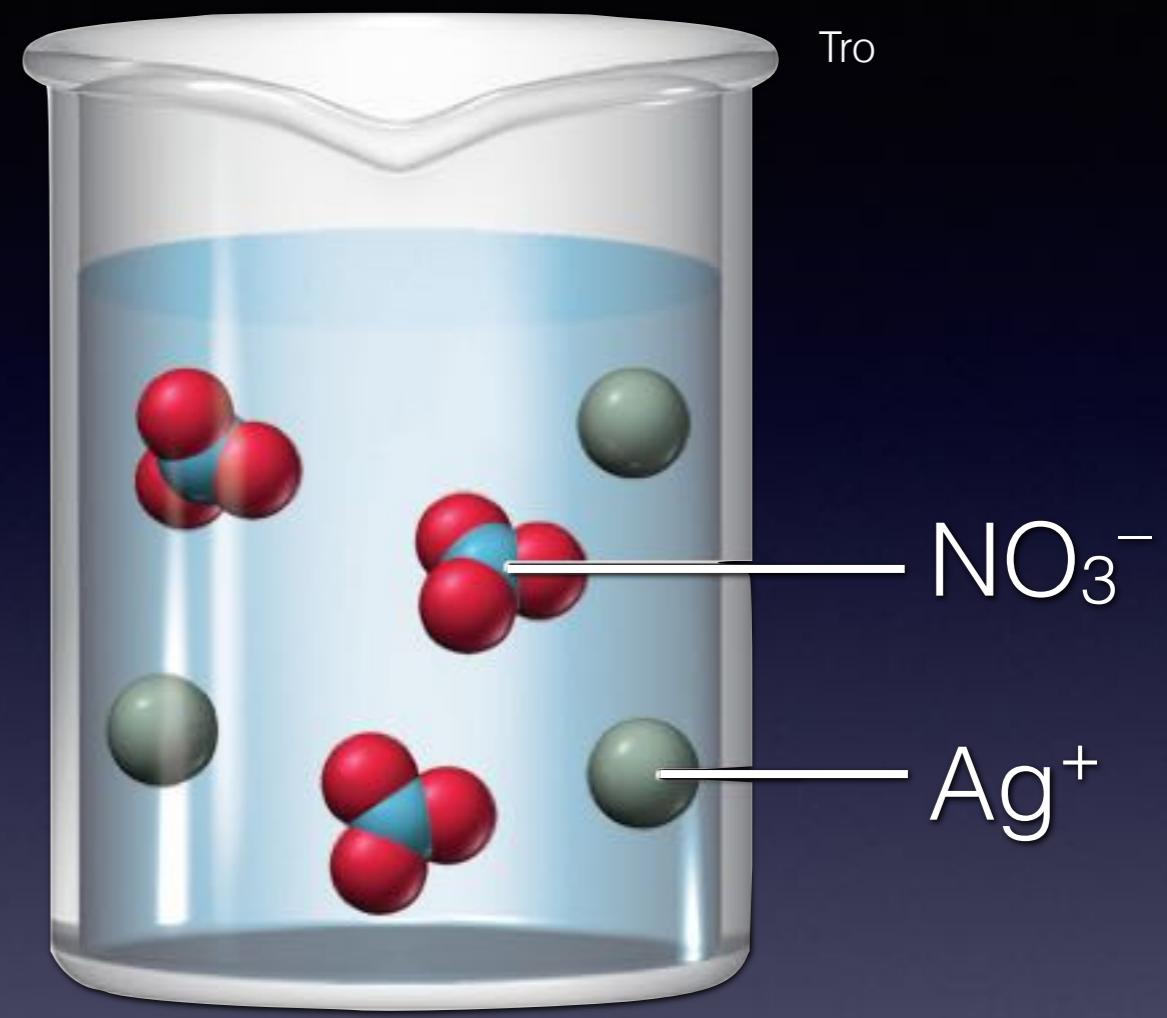
AgCl is
insoluble in water

... and sometimes
it's both...





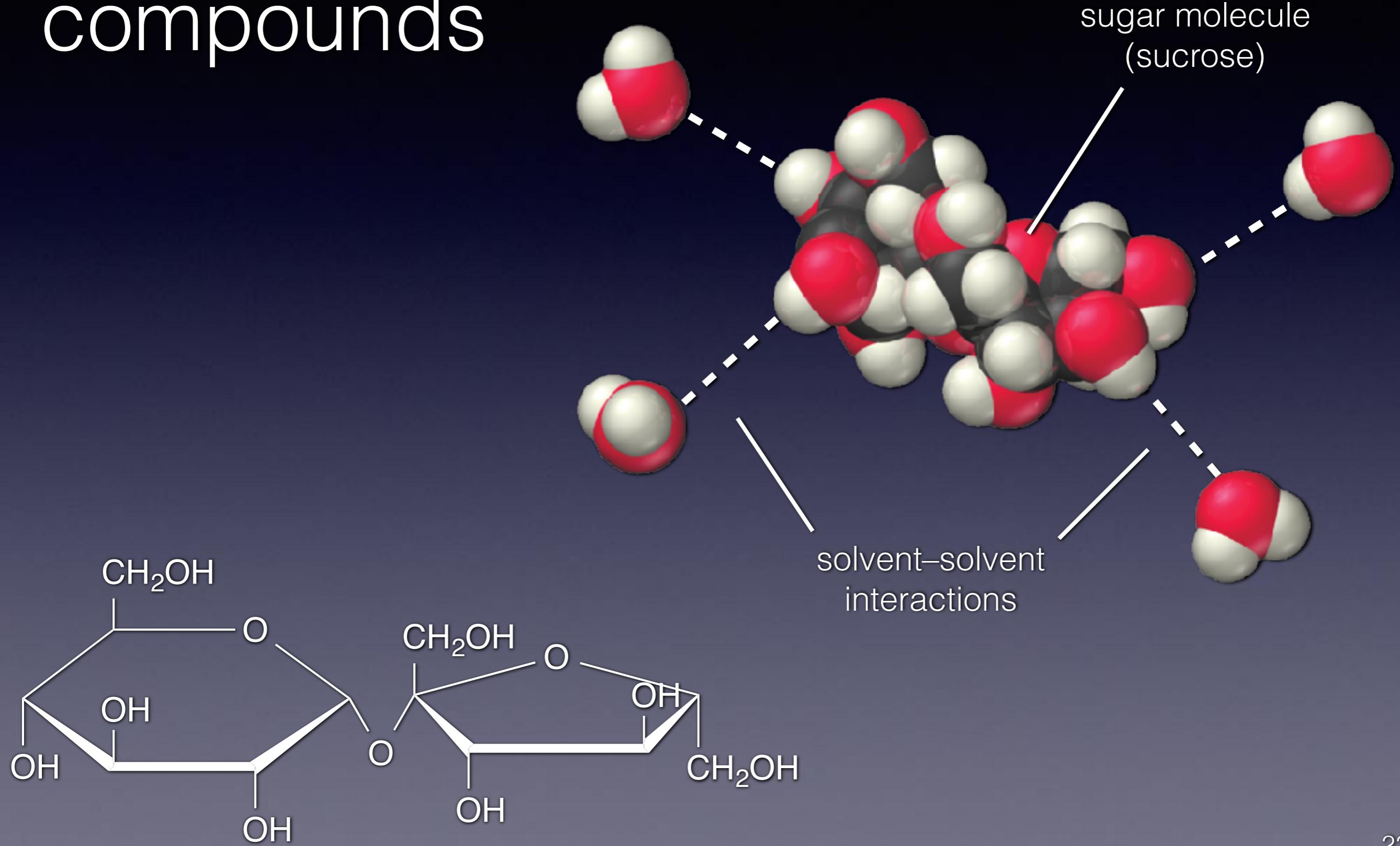
Silver chloride
added to water...

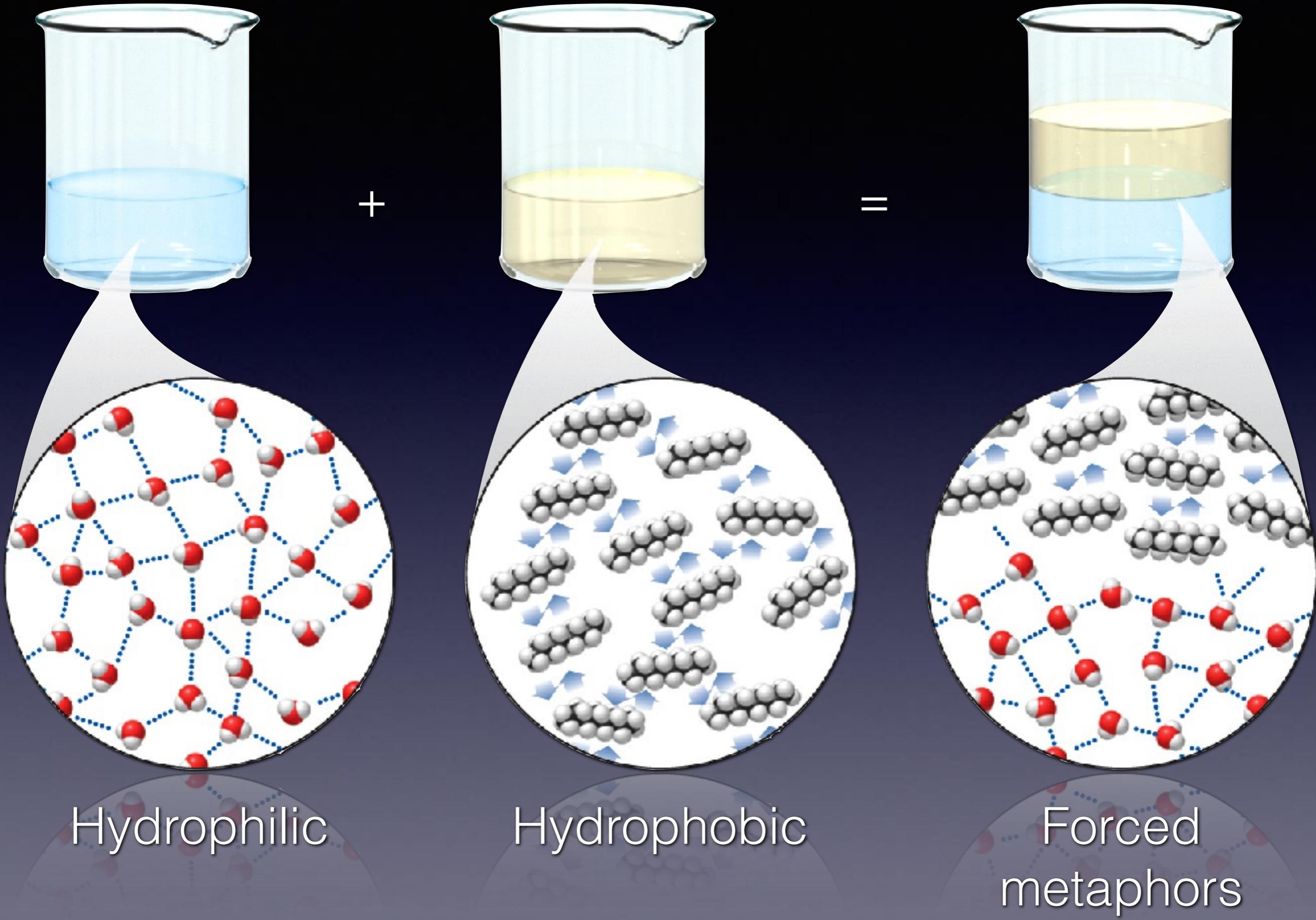


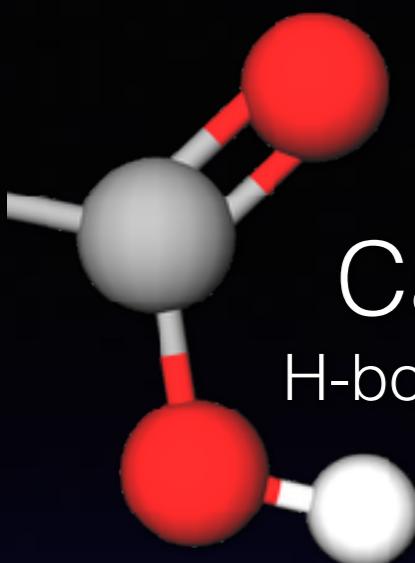
Silver nitrate
added to water...

Tro

Solubility of molecular compounds







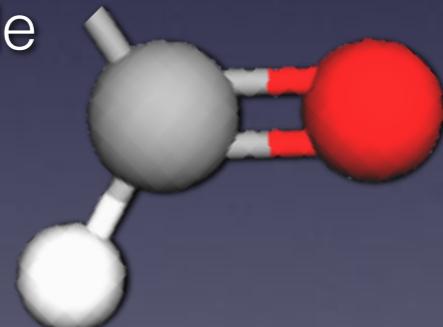
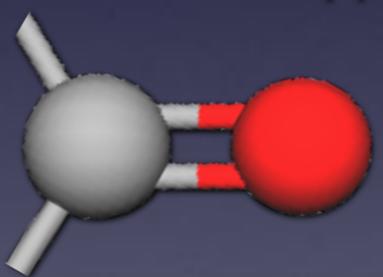
Carboxylic acids
H-bond acceptors and donors

Trends in solubility

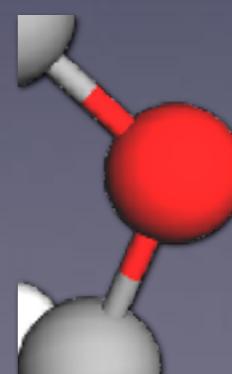
Alcohols
H-bond acceptors and donors

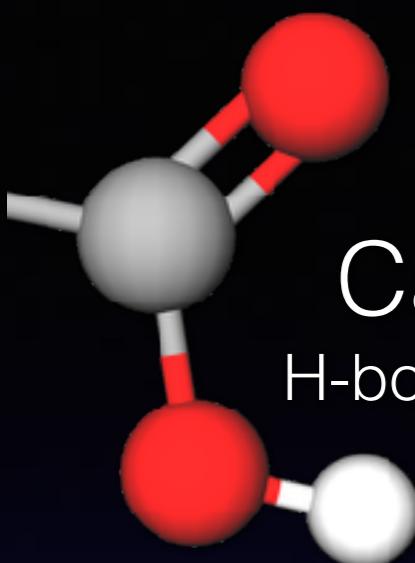


Ketones and aldehydes
H-bond acceptors
Strong dipole



Ethers
H-bond acceptors
Weak dipole





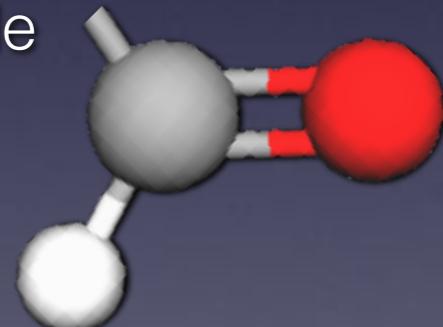
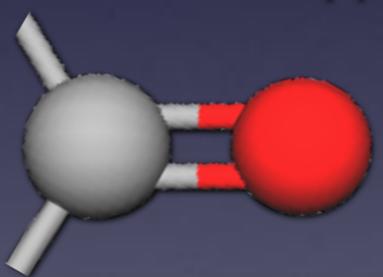
Carboxylic acids
H-bond acceptors and donors
very soluble

Trends in solubility

Alcohols
H-bond acceptors and donors
very soluble



Ketones and aldehydes
H-bond acceptors
Strong dipole
soluble



Ethers
H-bond acceptors
Weak dipole
poorly soluble

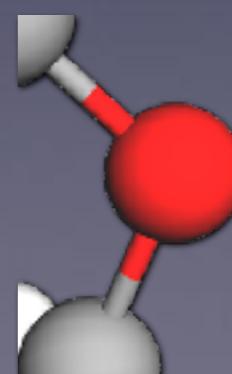


TABLE 6.5 Solubilities of Some Ketones in Water

Compound	Condensed Molecular Structure	Solubility in Water (g/100 mL)
2-Propanone	$\text{H}_3\text{C}-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{CH}_3$	Miscible
2-Butanone	$\text{H}_3\text{C}-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{CH}_2\text{CH}_3$	25.6
2-Pentanone	$\text{H}_3\text{C}-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{CH}_2\text{CH}_2\text{CH}_3$	4.3
2-Hexanone	$\text{H}_3\text{C}-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{(CH}_2)_3\text{CH}_3$	1.4
2-Heptanone	$\text{H}_3\text{C}-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{(CH}_2)_4\text{CH}_3$	0.4



Where did we go today?

Ch1010-A17-A03 Lecture 24

- §6.1 London fog and also dispersion
- §6.2 Polar interactions
- Great problems at chapter's end:
6.11, 6.14, 6.19, 6.23, 6.28

Next time...

- §6.3 Solubility
- §6.4 Phase diagrams