Foams, Colloids, and Ice Cream

Emulsions, Foams, and Colloidal Suspensions

Emulsion

- drops of an immiscible fluid
- in a second fluid

Foam

- drops filled with air
- in a fluid

Colloid

Foams

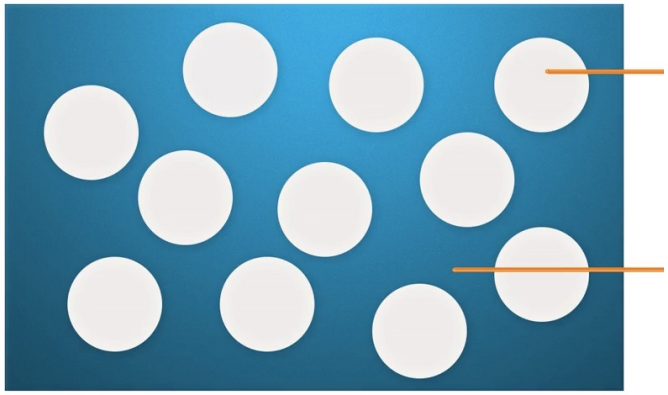
Foams are very much like emulsions

- instead of having drops of a fluid inside a second fluid, they have bubbles of air inside of a fluid.
  - can have a foam that is solid
  - can have a foam that's liquid-like

Foams

An amazing thing about a foam is that you're mixing a fluid and a gas.

- a fluid wants sit at the bottom of a bowl.
- a gas wants to expand everywhere.
- mix them together, and you make bubbles of the gas inside the fluid and you can end up with something that is a solid.



Foams

Drops in a foam can be destabilized much more easily than in the case of an emulsion. Why?

Air is much lighter (less dense)!

The bubbles tend to cream, go to the top, ***much more easily.***

Foams

Can whisk the air into the liquid to make the foam.

immersion blender

Incorporate air (e.g. KitchenAid)

Foams

Second way to make foam:

use whipped cream dispenser

- a compressed gas– typically, nitrous oxide, which is very soluble in things like milk.
- mixed with the milk under high pressure.

  – forcing the two to mix

Use high-pressure gas (e.g. iSi Whip)

Additional way to stabilize a foam

Besides adding a surfactant, there are other ways of stabilizing a foam

-can do this by gelling the liquid phase.

That's a very common way that chefs use to create desserts.

A mousse is a foam where the liquid phase has been gelled.

Tools for a gel:

- can freeze it
- can add some gelling agent

Emulsions, Foams, and Colloidal Suspensions

Emulsion

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Foam

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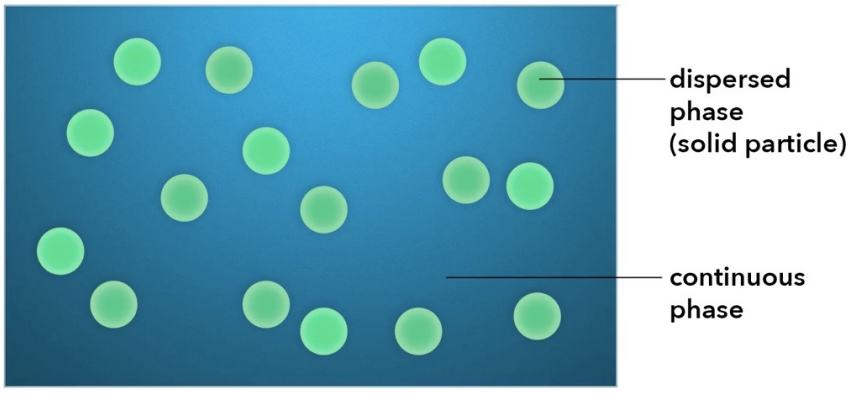
Colloid

immiscible: to not form a homogenous mixture when added together

Colloidal Suspension

a colloidal suspension is a suspension of small solid objects in the fluid.



Colloidal Suspension

Colloidal suspensions, aka colloidal dispersions are also commonly used in food.

An example is coffee.

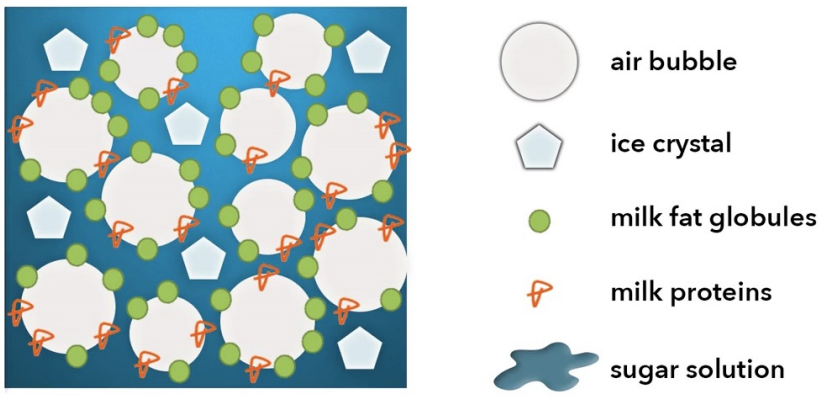
- The black in coffee is made up of small, black particles, or colloidal particles of coffee, that give the black color.

Ice Cream

ice cream encompasses all the types of dispersions

- a foam, an emulsion, and colloidal particles.

- a foam because there are lots of bubbles of air inside of it.
- an emulsion because of the fat drops in the milk.
- a colloidal suspension because some of these fat drops are solid like objects.



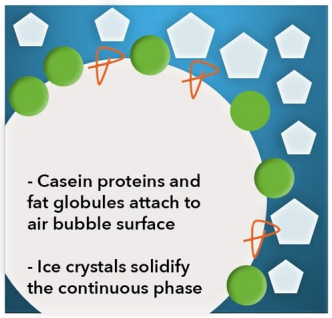
Ice Cream

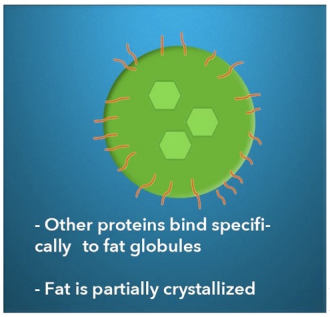
The stability of ice cream arises both because:

- there are colloidal particles or fat particles that stabilize the interface of the bubbles
- because the water phase is frozen and becomes a solid.
  - prevents the motion of the drops of the air from coming to one another and coalescing.

ICE CREAM IS A FOAM, EMULSION, AND DISPERSION

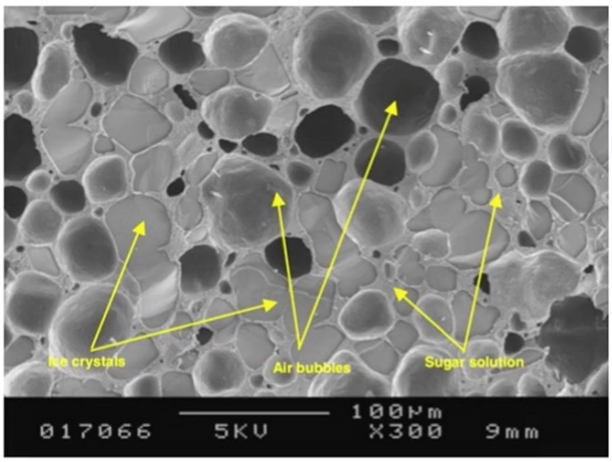
Stability depends on all properties





Ice Cream

A combination of a foam, emulsion, and crystals



C Clarke, "Physics of Ice Cream" Physics Educ. 2003.

Here's an image of ice cream taken with an electron microscope.

- You can see these bubbles of air.

Ice Cream

Ice Cream is a result of chemical technology

- More crystals (fat or water) lead to less smooth and more "crunchy" ice
- Whipping, emulsifiers and sugar all influence the crystals as they freeze
- To "ice the cream"
  - create an environment colder than the freezing point of the water in milk

Ice Cream

Freezing point depression

- A solution of water and solute (some other compound) will have a lower freezing point than pure water
- This is a result of ions interfering with the ability of water to form a lattice (cage) of bonded molecules.

Formally looking at melting point

The freezing point is influenced by *the small amount of dissolved solids (salt ions) rather than the solute (water molecules)*

$$\Delta T_f = K_f c_m$$

- ΔT_f = is the change of temp
- K_f = is a constant for the solvent (water)
- c_m = is the concentration of the ions

What does this tell us?

The more salt particles - the bigger the freezing point depression

- this is how frogs and other mammals can survive freezing