

London Dispersion Forces

Skills to Develop

- Define London dispersion forces

It's not too hard to see why dipole-dipole forces hold molecules like HF or H₂O together in the solid or liquid phase. However, let's think about the halogens. F₂ and Cl₂ are gases, Br₂ is a liquid, and I₂ is a solid at room temperature. But I₂ has no dipole moment to make attractions between the molecules. But actually, although I₂ has no permanent dipole moment, it can have a temporary dipole moment. We mentioned this before, when we talked about [polarizability](#). Go back and read that section.

London dispersion forces can explain how liquids and solids form in molecules with no permanent dipole moment. "Dispersion" means the way things are distributed or spread out. Because the electrons move around a lot, sometimes they may move in a way that creates a temporary dipole moment. The more electrons an atom has, the more easily this can happen, because the electrons are held more loosely, far from the nucleus. (Basically, the energy gaps between orbitals become smaller as we move to higher shells, allowing the electrons to more easily move into excited states, occupying orbitals higher than they need to. This gives them more flexibility to move around and create temporary dipole moments.) The technical word for an element that is polarizable, or able to have temporary dipoles, is "soft". In other words, it can squish and change shape. Elements that can't polarize easily (which usually means low atomic number) are called "hard".

An example of London dispersion forces for one helium atom causing a dipole to be created on a nearby helium atom.

Fluorine is really really hard. In F₂, both F atoms are holding all the electrons really tightly, trying to grab them and not share. In contrast, iodine is really soft. Its electrons are far away from the nucleus, and they can move around easily. If they all happen to move one direction, creating a temporary dipole, the other molecules nearby can adjust, making more dipoles to attract the first one. These are called induced dipoles, because they appear in response to the original accidental dipole. Lots of induced dipoles can create attraction between molecules, called London dispersion forces.

London dispersion forces are always present, but they vary widely in strength. In light atoms, they are very small, because there aren't many electrons and they are held tightly. In large atoms, they can be very big, because the atoms are very soft and easy to polarize. Generally, London dispersion forces depend on the atomic or molecular weight of the material. Heavier atoms or molecules have more electrons, and stronger London forces. This means that they are harder to melt or boil. This explains the states of the halogen molecules at room temperature.

Outside Links

- [Khan Academy: Van der Waals Forces](#) (12 min)
- [CrashCourse Chemistry: Liquids](#) (11 min)

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- [Emily V Eames](#) (City College of San Francisco)

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