Matter ... and Measure

Ancient Greeks looked at Earth as well, created theories of matter, reductionist, and construct: Four basic "elements" to all things: EARTH, AIR, FIRE, WATER

Q: Why not? Can you think of anything not made up of these things? (Sunlight = fire)

Earth + Air + Water + Sun $\rightarrow$ plant $\rightarrow$ life
plant $\rightarrow$ food $\rightarrow$ humans, etc.

Perfectly good theory - what are deficits??

Doesn't explain detail e.g., granite vs. sandstone vs. wood

Democritus - matter not infinitely divisible, reach small limit - atoms, too small to see

Ideaology-driven hypothesis - no data for or against it

Explains form as separate from content
large rocks, small rocks
large lakes, small lakes

etc.

Odor is direct example of invisible atom nature
Evidence for atomic theory of matter

1. Odors
2. Chemical reactions - whole number weight ratios
   \[ 2H_2 + O_2 \rightarrow 2H_2O \]
   \[ 1g + 8g \rightarrow 9g \]
   \( \text{H:O} = 1:8 \)
   suggests fundamental unit of combination
3. Brownian motion - suggests microscopic collisions
4. Chemical elements (from chemists)
   \( \Rightarrow \) Periodic Table

Four States of Matter

\[ \text{SOLID} \rightarrow \text{LIQUID} \rightarrow \text{GAS} \rightarrow \text{PLASMA} \]

- dense? yes yes no no
- fluid? no yes yes yes
- compressible? no yes yes yes
- crystalline? yes no yes no
- conductor? some (Cu) some (Hg) no yes

Water - very special properties:
- expands when freezes \( \Rightarrow \) ice floats
- heaviest (most dense) at 34 F = +1 C \( \Rightarrow \) Fall turnover

Demo

\[ \text{ice bomb} \]