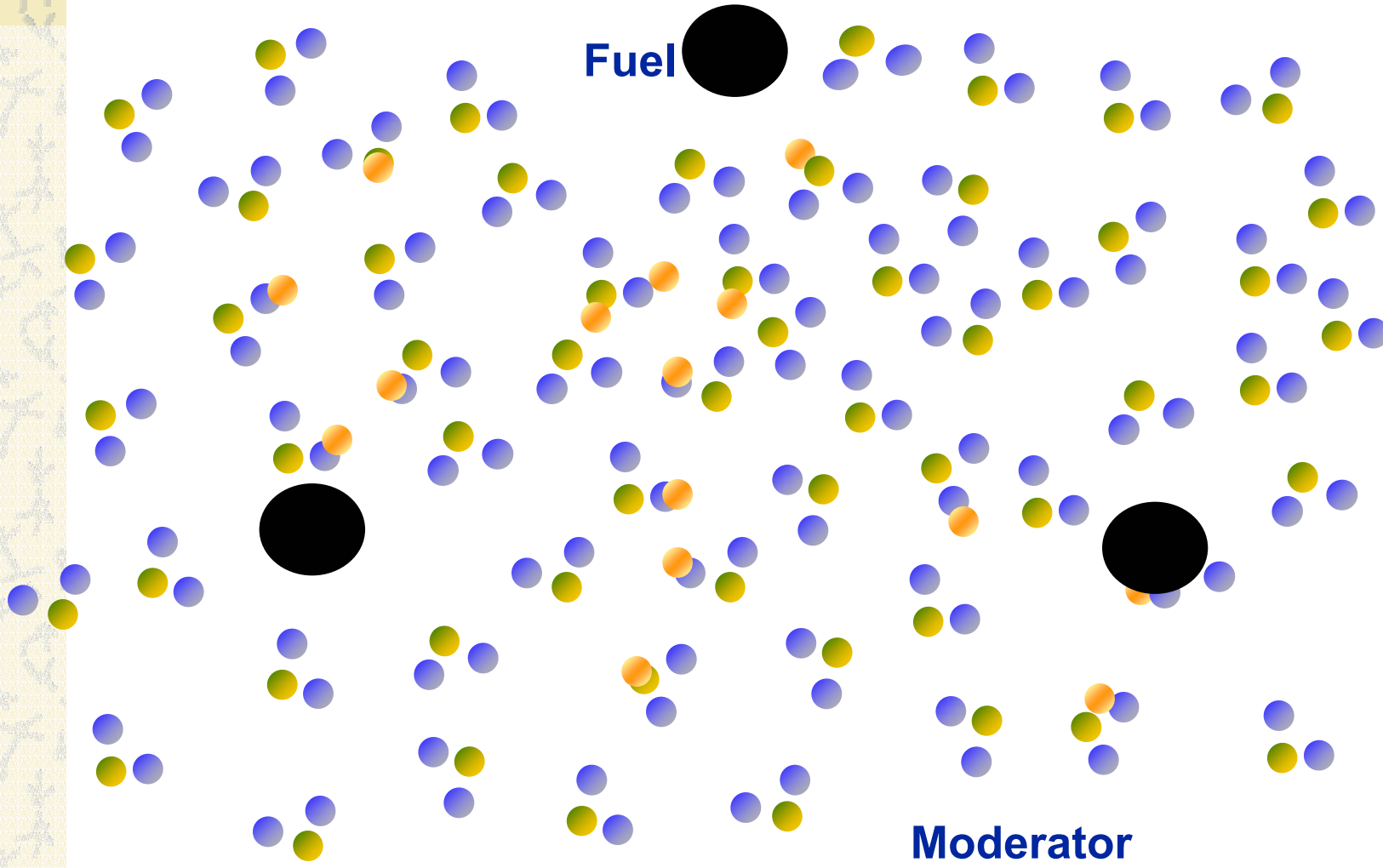
Fuel, Moderator and Reactor Arrangement

Self Sustaining Chain Reaction

- Natural uranium fuel
  - Fission of U-235 highly probably with thermal neutrons
  - Neutrons near resonance peaks of U-238 will likely undergo radiative capture
- Neutrons must be slowed away from the fuel
- In fuel neutrons have about a 50:50 chance of being absorbed by U-235 and U-238
  - Must slow down and and put $\approx$ 2 neutrons per fission back into fuel

Moderation



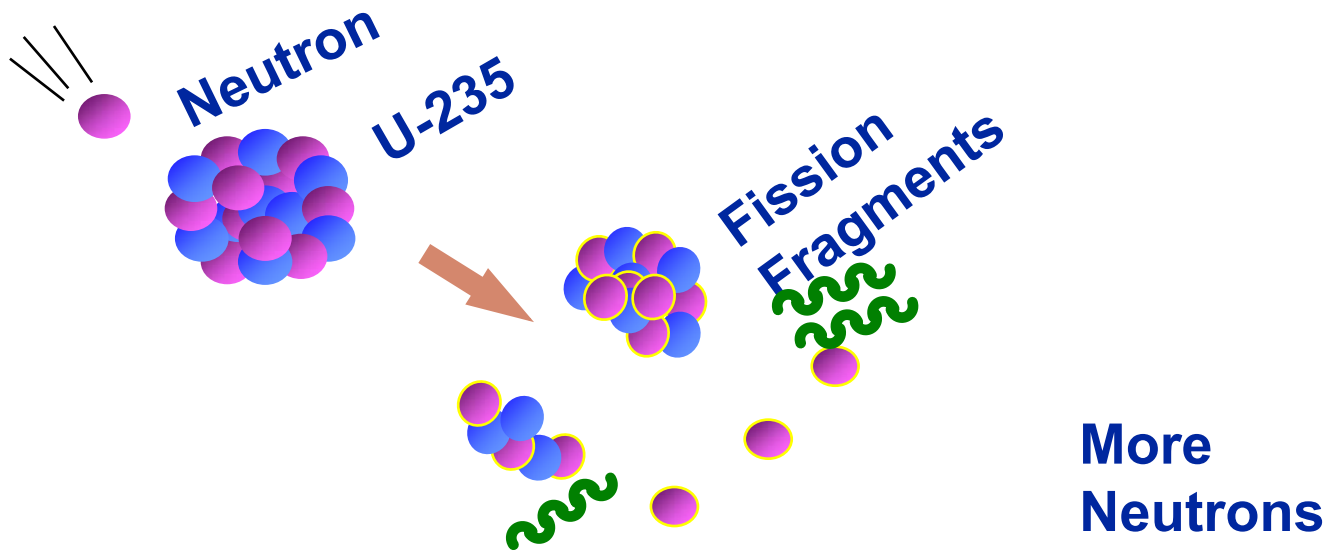
Moderation

- Neutrons are slowed by bouncing off other nuclei
  - Mostly elastic collisions
- Basic requirements of moderator
  - Slow neutrons in a minimum of collisions
    - Keep distances small
    - Maximum kinetic transfer in collision is between particles of equal mass
  - Absorb only a few neutrons

Moderators

Moderator	# of collisions	σ_s	σ_a
H_2O	20	103	0.664
D_2O	36	13.6	0.0010
C	115	4.8	0.0034

Bottom Line



With natural U_2O the only moderator is heavy water.

Fresh and Equilibrium Fuelling

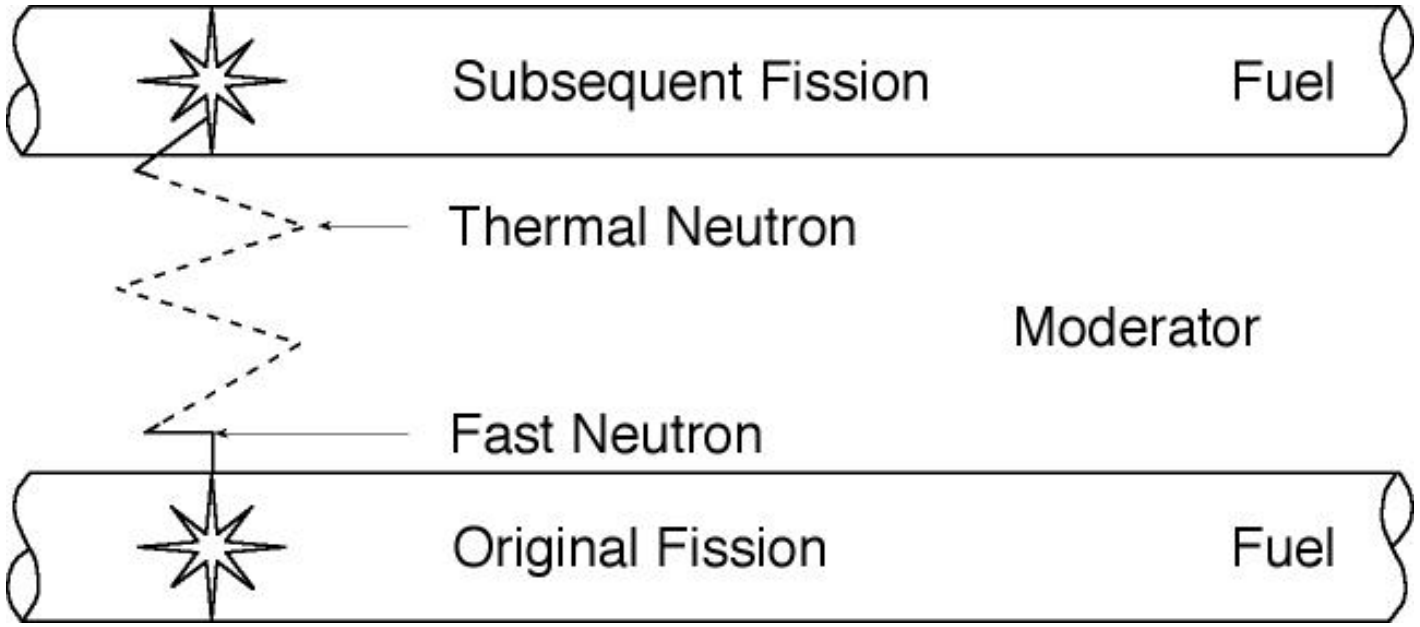
$$ {}^{1}_{0}n + {}^{238}_{92}U \rightarrow {}^{239}_{92}U + \gamma $$

$$ {}^{239}_{92}U \rightarrow {}^{239}_{93}Np + \beta + \gamma \qquad T½ = 23.5 \text{ min.} $$

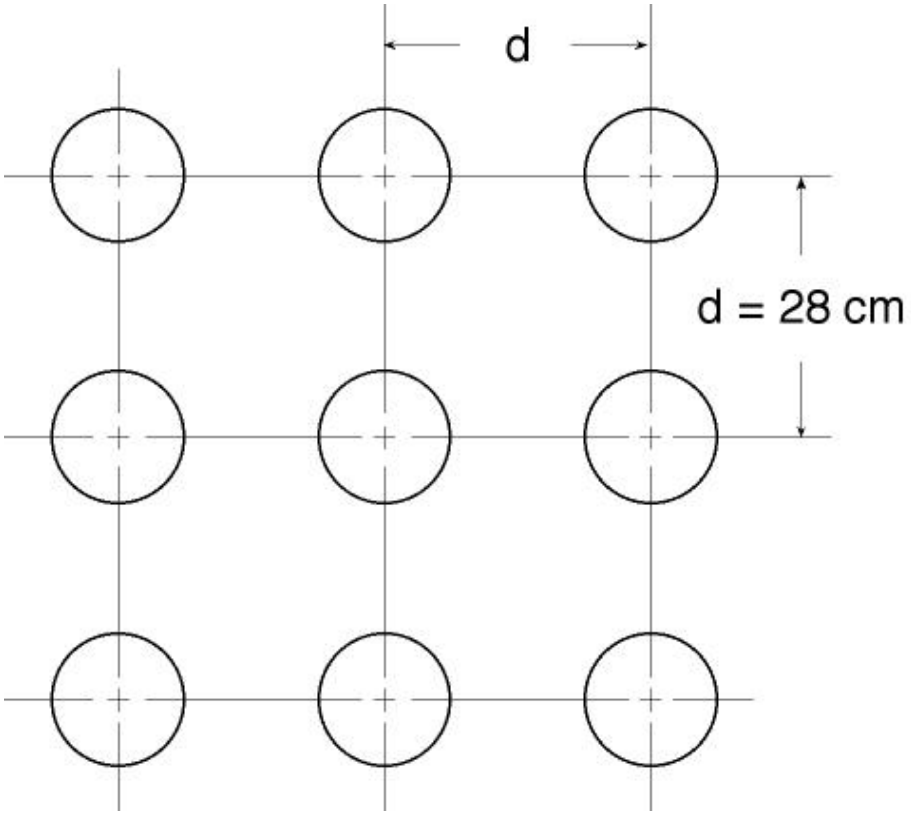
$$ {}^{239}_{93}Np \rightarrow {}^{239}_{94}Pu + \beta + \gamma \qquad T½ = 2.35 \text{ d.} $$

- Pu-239 is fissile
  - Some fuel is produced
- Fission products slowly build
  - Adds neutron absorbers

Axial Reactor Arrangement



Radial Reactor Arrangement



Distance between channels is the lattice pitch