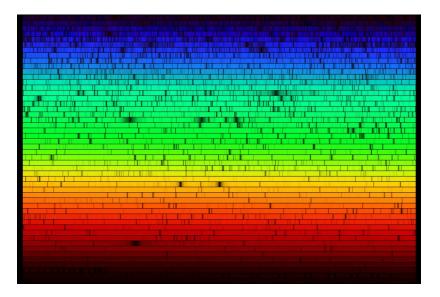
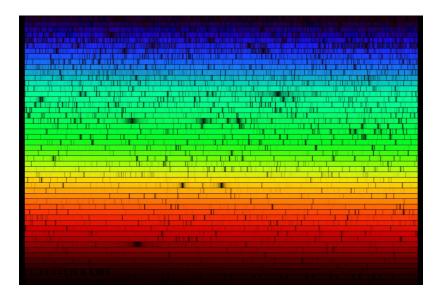


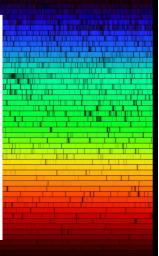
# What is this? The Sun's Spectrum



# What is this? The Sun's Spectrum What are the gaps? 3



- Excited atoms in the photosphere of the Sun emit light as the atoms relax from a high-energy, excited state to a lower energy one.
- Other atoms in the photosphere may absorb that light if its energy corresponds precisely to the difference in energy between two states in the absorber.
- The absorbed light is eventually re-emitted, but that light may go off in another direction or at a different energy.

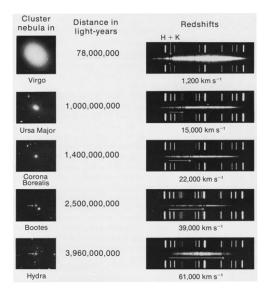


# Optical Spectra of Stars, Nebulae, Atoms



Cosmology

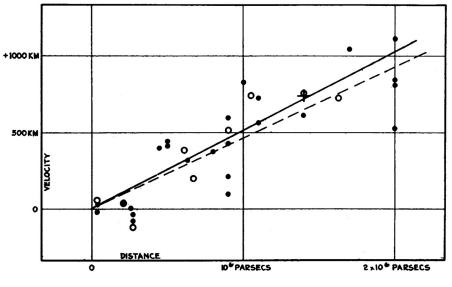
## Red Shift of Optical Spectra of Stars, Nebulae, Atoms



Cosmology

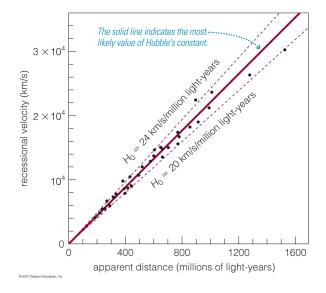
6

#### Distance-Velocity Relationship of Galaxies

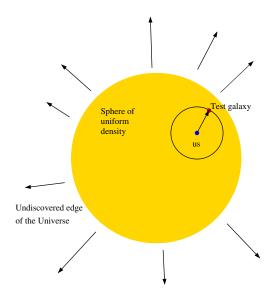


E.Hubble, PNAS 15, no. 3, 168 (1929).

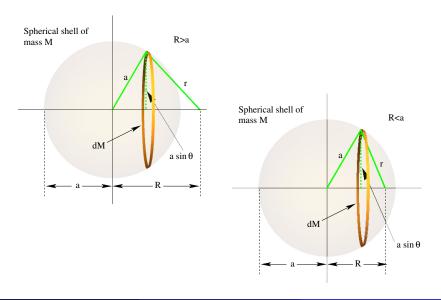
#### Distance-Velocity Relationship of Galaxies



## Expanding Unverse

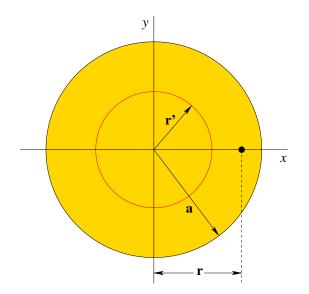


## Potential From a Uniform Spherical Mass



10

### Potential From a Uniform Spherical Mass



11

- Is our model any good?
- What determines the ultimate fate of the Universe?
- What is  $\vec{r}(t)$ ?
- What is  $\rho(t)$ ?
- How old is the Universe?

