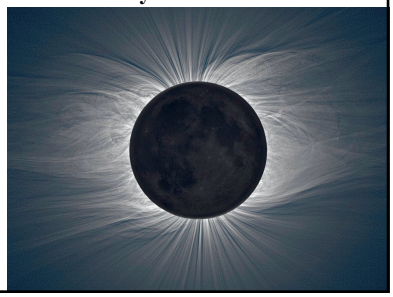
Coronal equilibrium

- Mechanical energy sets kinetic temperature
- "Coronal" command in Cloudy
- No ionizing radiation
  - (no light at all)
- Collisional ionization, due to collision by thermal electrons



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Coronal equilibrium

- Electron collisions cause ionization from ground state
- Balanced with all recombinations to all states
  - Which decay down to ground
- $n(H^0) n_e c_{ion} = n_e n_p \alpha_{rec}(T)$
- $\frac{n_p}{n(H^0)} = \frac{c_{ion}}{\alpha_{rec}(T)}$ (no density dependence)

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Coronal model with Cloudy

- Unit cell
- In coronal equilibrium (unit volume)
- Unit density (n=1 cm^{-3})

```
set save prefix "T7"
set dr 0
stop zone 2
coronal 4
hden 0 % this is not a realistic density for sun, 1e10 cm-3 more typical
iterate
print last iteration
save continuum last units microns ".con"
save cooling ".col"
```

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Try different temperatures

- **Coronal command**
  - Log T=2, 3, 4, 5, 6, 7, 8
- **Unit cell**
- **Must include "cosmic ray background" and grains when molecules are significant**
- **Plot spectrum**
  - X-axis log wavelength from 1e-4 to 1e3 microns
  - Y-axis linear intensity, with strongest line at the top

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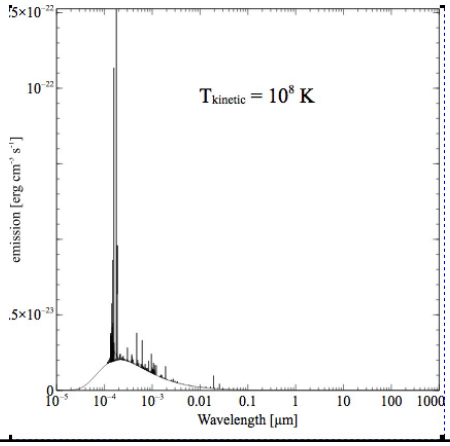

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Coronal equilibrium

- **What is spectrum, cooling, at each temperature**

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Very low temperature care

- **Add grains**
  - H_2 forms on grain surfaces
- **Add cosmic rays**
- $n(H^0)n_e c_{ion} = n_e n_p \alpha_{rec}(T)$ **(no CRs)**
- $n(H^0)(n_e c_{ion} + c_{CR}) = n_e n_p \alpha_{rec}(T)$
- $\frac{n_p}{n(H^0)} = \frac{(n_e c_{ion} + c_{cr})}{n_e \alpha_{rec}(T)}$
- $n_e \to 0, \quad \frac{n_p}{n(H^0)} \to \infty$

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