Plasma Dizo 3/24/2021

Optically Thin Radiative Loss in

Stellar Coronae

(1) The corona's emission mostly comes from Active Regions (ARs) and X-ray Bright Points (XBPs) at $10^6 \lesssim T \lesssim 3 \times 10^6 K$, $n \simeq 3 \times 10^9 \ cm^{-3}$

(2) Emission inside ARs and XBPs mostly from loops, which align the magnetic field

(3) Emission is optically thin, i.e. photons from the corona travel freely to outer space

(4) Emission is mostly from heavy ion emission lines, e.g. Fe X, Fe XV, etc. (There is also some free-free emission). ~~Hence~~ Those ions are collisionally excited, i.e. a collision of p^+ or e^- with an ion takes a bound electron to a higher energy state, after which the electron falls back emitting a photon

PLASMA ASTRO 3/24/2021

(5) HENCE, THE EMISSION RATE FOR ONE LINE SCALES WITH DENSITY OF THE IMPACTING PARTICLES, TIMES THE DENSITY OF THE ION, WHICH IS THE PROTON DENSITY TIMES THE ABUNDANCE. THUS:

$$E_R \sim n^2$$

(5) ADDING UP THE CONTRIBUTIONS FROM MULTIPLE SPECIES (Fe, Mg, C, O, ETC), THEIR IONIZATION STATE (T-DEPENDENT), AND TRANSITION PROBABILITY (QUANTUM MECHANICS) WE FIND THE RADIATIVE LOSS RATE:

$$E_R = \rho^2 \Psi(T)$$

ρ → DENSITY; $\Psi(T)$ → CALCULATED RATE

(6) USING THE GAS LAW ($P = 2\rho R T$) WE CAN ALSO EXPRESS THAT AS:

$$E_R = \frac{P^2}{4R^2T^2}\Psi(T) = P^2\chi(T)$$

(6) THIS CURVE, HAS BEEN CALCULATED BY MANY, E.g. MARTENS ET AL. (2000)