DR

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Fe $3\mathrm{p}^q \quad (q = 1 - 6)$

Interest:

Determination of the ionization balance of the M-shell Fe ions which give rise to the prominent unresolved-transition-array X-ray absorption feature found in the spectrum of many active galactic nuclei. This feature is poorly described by CLOUDY and ION, necessitating an $ad\ hoc$ modification to the low-temperature DR rate coefficients.

Detailed comparison between theory and experiment for Fe^{13+} Schmidt et al ApJ v641, L157 (2006) and Badnell JPB At Press.

Target:

$1: \quad 3\mathrm{s}^2 3\mathrm{p}^q\,, \qquad 2: \quad 3\mathrm{s}3\mathrm{p}^{q+1}\,, \quad 3: \quad 3\mathrm{s}^2 3\mathrm{p}^{q-1}3\mathrm{d}\,,$

$4: \quad 3\mathrm{p}^{q+2}\,, \qquad 5: \quad 3\mathrm{s}3\mathrm{p}^q 3\mathrm{d}\,, \quad 6: \quad 3\mathrm{s}^2 3\mathrm{p}^{q-2}3\mathrm{d}^2$

$7: \quad 3\mathrm{p}^{q+1}3\mathrm{d}\,.$

$8: \quad 3\mathrm{s}3\mathrm{p}^{q-1}3\mathrm{d}^2$

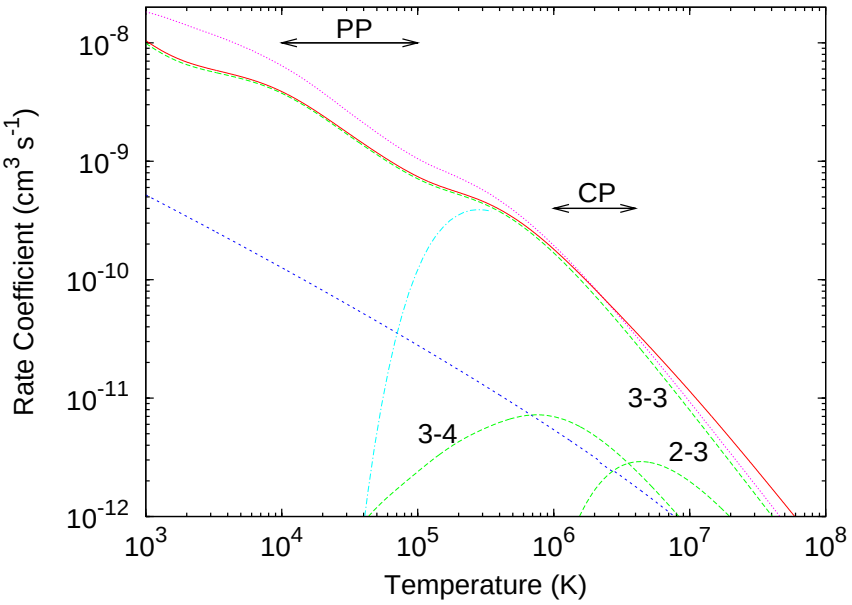


Figure 1: Maxwellian rate coefficients for Fe^{13+}. Solid (red) curve, total DR-plus-RR; short-dashed (blue) curve, RR; long-dashed (green) curves, DR for $3-3$, $3-4$ and $2-3$ core-excitations. All this work. Dot-dashed (light blue) curve, DR of Arnaud and Raymond (1992). Dotted (purple) curve, experimentally based total of Schmidt et al (2006). PP and CP denote typical photoionized and electron-collisional plasma temperature ranges, respectively, for Fe^{13+} (Kallman and Bautista 2001 and Mazzotta et al 1998).

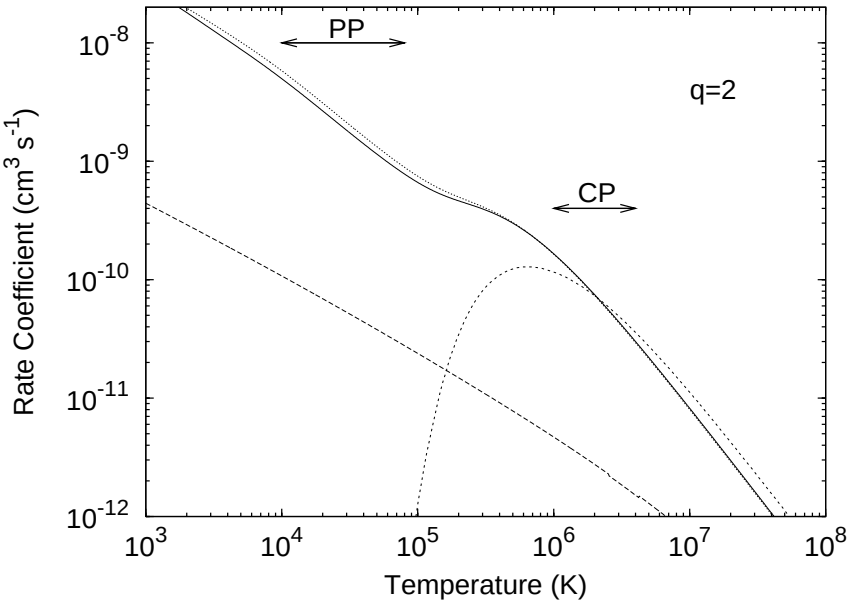
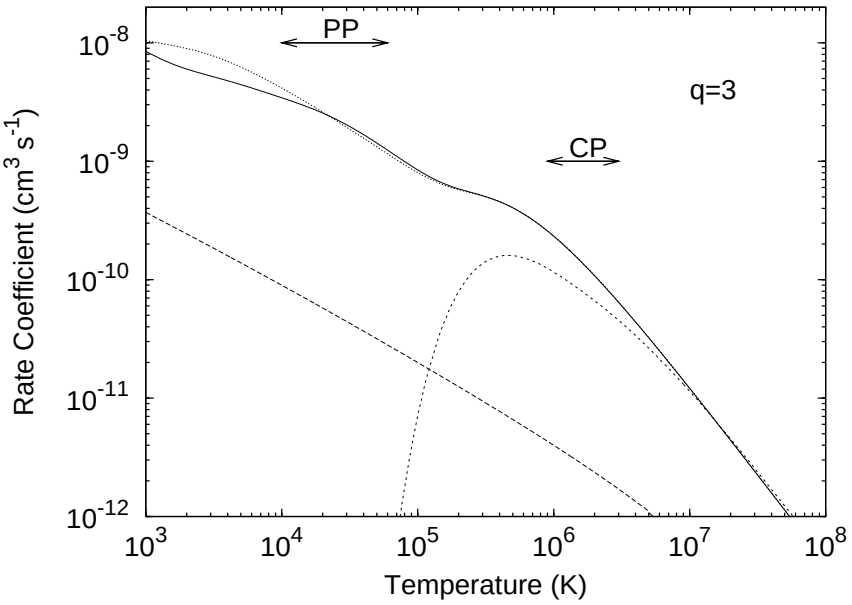
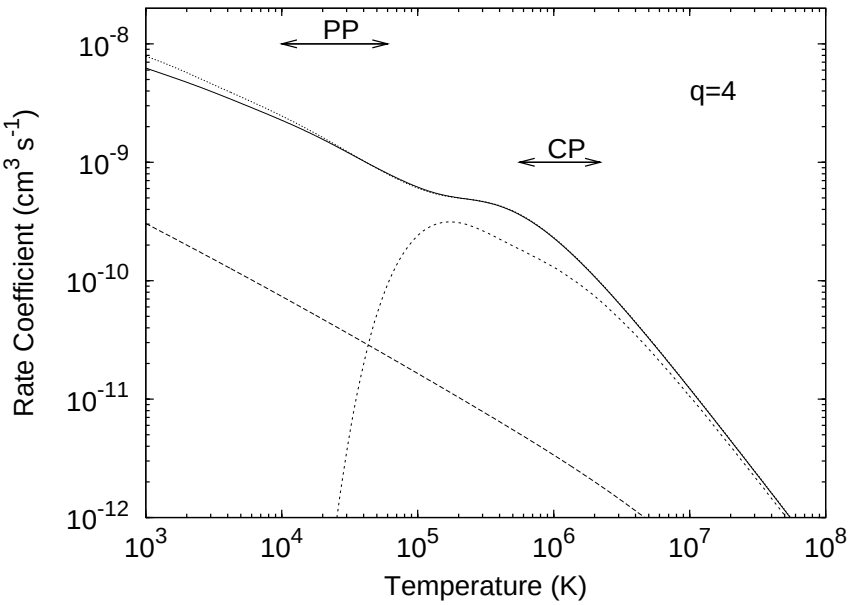
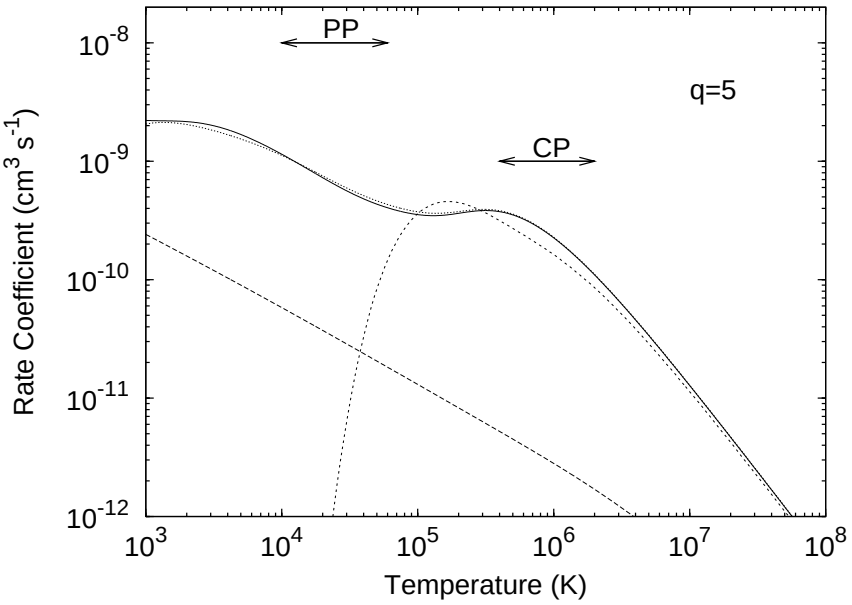
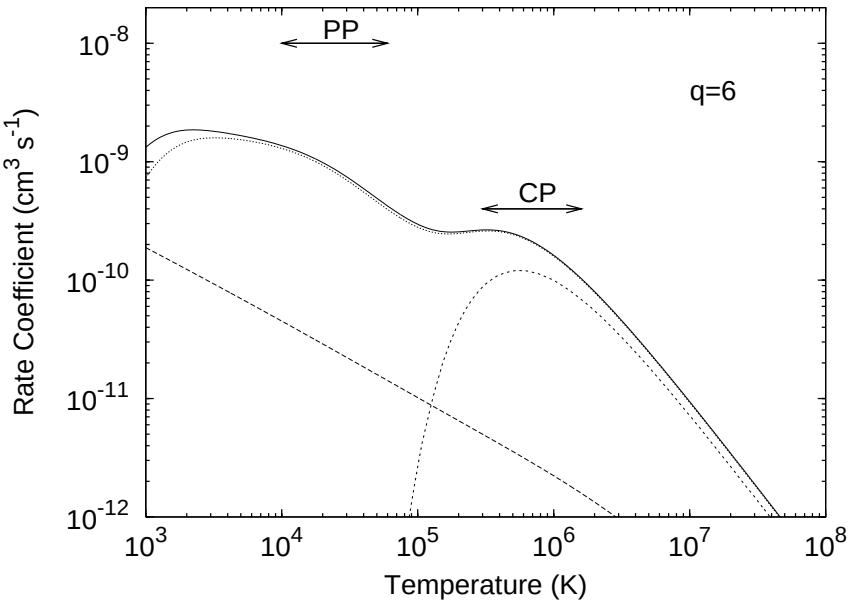


Figure 2: Total ground-level rate coefficients for Fe^{12+} ($q = 2$). Solid curve, DR (7CF); dotted curve, DR (8CF); long-dashed curve, RR; all present AUTOSTRUCTURE results. Short-dashed curve, recommended DR data of Arnaud & Raymond (1992). PP and CP denote typical photoionized and electron-collisional plasma temperature ranges, respectively, for Fe^{12+} Kallman & Bautista (2001) and Mazzotta et al (1998).


PP
CP
q=3
Rate Coefficient (cm^3 s^{-1})
Temperature (K)
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^3
10^4
10^5
10^6
10^7
10^8


PP
CP
q=4
Rate Coefficient (cm^3 s^{-1})
Temperature (K)
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^3
10^4
10^5
10^6
10^7
10^8


PP
CP
q=5
Rate Coefficient (cm^3 s^{-1})
Temperature (K)
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^3
10^4
10^5
10^6
10^7
10^8


PP
CP
q=6
Rate Coefficient (cm^3 s^{-1})
Temperature (K)
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^3
10^4
10^5
10^6
10^7
10^8

Summary:

We obtain total DR rate coefficients for the initial ground-level which are an order of magnitude larger than those corresponding to radiative recombination (RR), at temperatures where Fe $3\mathrm{p}^q$ $(q = 2 - 6)$ ions are abundant in photoionized plasmas. The resultant total (DR+RR) rate coefficients are then an order of magnitude larger than those currently in use by photoionized plasma modeling codes such as CLOUDY, ION and XSTAR.

Future:

S^{q+}, Fe $3d^q$ etc.

See Badnell ApJ v651, L73 (2006).

Revision of photoionization balance in CLOUDY underway (for all DR data). E.g. find significant changes to thermal equilibrium curve for warm absorbers (the partially ionized optically thin gas along the line of sight to the centre of an AGN).