9. ANEXO I: SIGLAS

9.1 Abreviaturas Globales

A : Masa atómica.

A_k : Apantallamiento externo de los electrones en orbitales más externos al considerado k .

A_{ij} : Coeficiente de Einstein de emisión espontánea entre los orbitales relativistas i y j .

$B(hv)$: Campo de radiación de Planck procedente de un cuerpo negro.

C_S : Velocidad del sonido.

$D_k \equiv g_k$: Degeneración afectada por la ionización por presión del orbital relativista k .

D_k^0 : Degeneración máxima o peso estadístico del orbital relativista k .

$df_i / d\in$: Fuerza de oscilador ligado-libre diferencial de la transición desde el orbital relativista i al continuo.

$E_1(u) = \int_1^\infty dx \frac{e^{-ux}}{x}$: Primera integral exponencial.

f_{ij} : Fuerza de oscilador de absorción para una transición entre los orbitales relativistas ligados i y j .

$f_{i,\in_c l'}$: Fuerza de oscilador ligado-libre de la transición desde el orbital relativista i al continuo, tal que el electrón queda en el continuo con energía positiva $\in_c$ y número cuántico orbital l' .

$f_{nl,\varepsilon l'}$: Fuerza de oscilador de fotoionización / ionización colisional desde el orbital relativista caracterizado por los números cuánticos n y l , siendo las únicas transiciones permitidas aquellas en las que el salto en el número cuántico orbital satisface la relación $l' = l \pm 1$, tal que el electrón queda en el continuo con energía positiva ε .

F_P : Función de distribución de fotones.

h : Constante de Planck.

$\hbar$: Constante de Planck reducida.

I : Intensidad del campo de radiación.

$I_i = -\in_i \; eV$: Potencial de ionización del nivel relativista i .

j : Número cuántico relativista.

k_B : Constante de Boltzmann.

$k_B T_e \; eV$: Temperatura electrónica.

$K(hv) \equiv K_V$: Opacidad espectral frecuencial.

$K_P \; cm^2/g$: Opacidad media de Planck con formalismo UTA.

$K_R \; cm^2/g$: Opacidad media de Rosseland con formalismo UTA.

$K_{P1} \equiv K_{PMUTA} \; cm^2/g$: Opacidad media de Planck con formalismo MUTA.

$K_{R1} \equiv K_{RMUTA} \; cm^2/g$: Opacidad media de Rosseland con formalismo MUTA.

$L \equiv D \; cm$: Longitud característica del plasma.

l : Número cuántico orbital.

$L_P \equiv l_P \; cm$: Camino libre medio de Planck.

$L_R \equiv l_R \; cm$: Camino libre medio de Rosseland.

l_Z : Longitud de la máquina Z-Pinch.

m_i : Masa del ión.

n : Número cuántico principal.

N_A : Número de Avogadro.

$N_e \;\; cm^{-3}$: Densidad electrónica por centímetro cúbico.

$N_i \;\; cm^{-3}$: Densidad iónica por centímetro cúbico.

P_C : Probabilidad de confinamiento de fotones.

P_k : Población fraccionaria del orbital relativista k .

Q_k : Carga apantallada del orbital relativista k .

R_i : Radio del ión esfera.

r_k^0 : Radio del orbital relativista k del átomo neutro aislado.

$r_{nl,\varepsilon l'}$: Elemento de matriz relativista para el cálculo de las fuerzas de oscilador ligado-libre.

r_p : Radio de la máquina Z-Pinch.

$S_{kk'}$**:** Perfil de línea Voigt para la transición ligado-ligado entre los orbitales relativistas k y k'.

$T_e \equiv T \quad eV$: Temperatura electrónica.

$T_R \equiv T_{rad} \quad eV$: Temperatura de radiación.

$T_v \;\; eV$: Temperatura denominada “Brightness Temperature”.

V_{ik}, V_{jk}: Energías de interacción electrónica entre los niveles (i,k) y (j,k) que representan la variación de la energía en el nivel i o j cuando se añade un electrón en el nivel k .

X_{dil} : Factor de dilución.

Z : Número atómico.

Z_{bar} : Grado medio de ionización.

$z = Z_{bar} + 1$: Ionicidad del plasma.

$\beta = 1/k_B T$: Inverso de la temperatura.

ε_i eV : Autovalor de energía de la ecuación de Dirac del orbital relativista i.

$\in_j$ eV : Energía del orbital relativista j en la configuración de átomo medio.

$\in_{ij} = \in_j - \in_i$ eV : Energía de excitación entre los orbitales relativistas i y j.

$\delta_{kk'}$: Delta de Kronecker entre los orbitales relativistas k y k'.

μ_e : Potencial químico electrónico.

η_e : Potencial químico electrónico reducido.

$\sigma_{kk'}$: Constante de apantallamiento entre los orbitales relativistas k y k'.

σ_R^{ic} : Sección eficaz de fotoionización.

σ_{bb} : Sección eficaz de fotoabsorción ligado-ligado.

σ_{bf} : Sección eficaz de fotoabsorción ligado-libre.

σ_{ff} : Sección eficaz de fotoabsorción libre-libre.

$\tau(h\nu)$: Espesor óptico del medio o plasma caracterizado por una dimensión característica.

ξ $erg.cm/s$: Parámetro de ionización.

Λ_{ij} : Factor de escape para la emisión espontánea A_{ij} entre los orbitales relativistas i y j.

ΔI : Variación en el potencial de ionización o energía de ligadura por la depresión del continuo.

$(\partial B_\nu / \partial T)$: Función de pesado para K_R dependiente de la distribución Planckiana, es decir, radiación emitida por un cuerpo negro siendo T la temperatura de la radiación.

9.2 Constantes Numéricas

$a_0 = 0.5291772083 \times 10^{-8}$ cm : Radio de Bohr.

$c = 299792458 \times 10^2 \; cm/s$: Velocidad de la luz.

$e^2 = 1.4399652 \times 10^{-7} \quad eVcm$: Carga del electrón al cuadrado.

$h = 6.626069 \times 10^{-34} \quad Js$: Constante de Planck.

$h = 4.13566727 \times 10^{-15} \quad eVs$: Constante de Planck.

$\hbar = 6.58211889 \times 10^{-16} \quad eVs$: Constante de Planck reducida.

$m_e = 9.109382 \times 10^{-31} \; kg$: Masa del electrón.

$m_e c^2 = mc = 0.510998902 \times 10^6 \; eV$: Masa en reposo del electrón.

$Ryd = I_H = -13.605698 \, eV$: Energía del estado fundamental del átomo de hidrógeno.

$(1kg) \; c^2 = 5.609589 \times 10^{35} \; eV$: Equivalente energético de la masa.

$\alpha = 7.297353 \times 10^{-3}$: Constante de estructura fina.

$\zeta_{Lotz} = 0.691$: Parámetro de aproximación de Lozt.

9.3 Procesos Atómicos

$\Re^-_{k \to j}$: Tasas que despueblan el orbital relativista k mediante transiciones al nivel j.

$\Re^+_{j \to k}$: Tasas que pueblan el orbital relativista k mediante transiciones desde el nivel j.

I_C^{ic}: Tasa (s^{-1}) de ionización colisional desde el orbital relativista i al continuo.

R_C^{ci}: Tasa (s^{-1}) de recombinación a tres cuerpos al orbital relativista i desde el continuo.

τ_{ij}^C: Tasa (s^{-1}) de excitación colisional desde el orbital relativista i al j.

τ_{ji}^C: Tasa (s^{-1}) de desexcitación colisional desde el orbital relativista j al i.

A_{ji}: Tasa (s^{-1}) de emisión espontánea desde el orbital relativista j al i.

τ_{ij}^{R}: Tasa (s^{-1}) de absorción estimulada o fotoexcitación desde el orbital relativista i al j.

τ_{ji}^{R}: Tasa (s^{-1}) de fotodesexcitación desde el orbital relativista j al i.

I_{R}^{ic}: Tasa (s^{-1}) de fotoionización desde el orbital relativista i al continuo.

R_{R}^{ci}: Tasa (s^{-1}) de fotorecombinación al orbital relativista i desde el continuo.

9.4 Notación de Códigos Atómicos y del Código Hidrodinámico

AA: Modelo de atómo medio (“Average Atom”).

DCA: Modelo de configuración detallada (“Detailed Configuration Accounting”).

DLA: Modelo de niveles detallado (“Detailed Level Accounting”).

DTA: Modelo de términos detallado (“Detailed Term Accounting”).

FAC: Código atómico flexible (“Flexible Atomic Code”).

$MUTA$: Formalismo de matrices de transiciones no resueltas acorde a un límite preestablecido (“Mixed Unresolved Transition Array”).

$NRSHM$: Nuevo Modelo hidrogenoide apantallado relativista (“New Relativistic Screened Hydrogenic Model”).

SCA: Modelo de superconfiguración (“Super Configuration Accounting”).

SHM: Modelo hidrogenoide apantallado (“Screened Hydrogenic Model”).

STA: Formalismo de matrices de transiciones no resueltas entre superconfiguraciones (“Super Transition Array”).

UTA: Formalismo de matrices de transiciones no resueltas (“Unresolved Transition Array”).

m_p: Masa del protón.

$N_e = n_e\ cm^{-3}$: Densidad electrónica por centímetro cúbico.

$N_i = n_i \ cm^{-3}$: Densidad iónica por centímetro cúbico.

$V \ cm^3 / g$: Volumen específico.

$V' \ cm^3$: Volumen geométrico.

P_q : Presión viscosa numérica artificial.

$\varepsilon_{e,i}$: Energía interna específica electrónica o iónica.

$Q_{e,i}$: Calor específico absorbido por electrones o iones.

H_e : Transporte térmico electrónico.

χ_e : Conductividad térmica electrónica promedio de la clásica y con efectos de degeneración cuántica de los electrones.

$FLFT$: Factor Limitador de Flujo Térmico (Thermal Flux Limiter Factor).

K : Intercambio colisional electrón-ión.

J : Emisión de Bremsstrahlung.

X_{BI} : Deposición de luz láser por bremsstrahlung inverso.

X_H : Deposición por pasaje de electrones supratérmicos.

Y_e : Deposición de productos de fusión en el subsistema electrones.

H_i : Transporte térmico iónico.

Q_V : Calentamiento viscoso de la onda de choque.

Y_i : Deposición de productos de fusión en el subsistema iones.

$C_{Ve,i}$: Calor específico a volumen constante de electrones o iones.

ΔF_{DC} : Corrección por depresión del continuo.

R_0 : Interfase plasma-vacío.

τ_{ei} : Tiempo de relajación electrón-ión.

K_λ : Coeficiente de atenuación por bremsstrahlung inverso.

W_0 : Cantidad total de energía a depositar por los electrones supratérmicos.

$W_d\ (l)$: Energía depositada al cabo de una penetración l en el material.

$f_T\ (l) = 1 - \frac{W_d\ (l)}{W_0}$: Fracción de energía transmitida de la posición l hacia adelante, que queda por transmitir, se asimila a una exponencial decreciente.

$R_S\,(t)$: Posición de la onda de choque en función del tiempo.

$\dot{R}_S$: Velocidad de propagación de la onda de choque en función del tiempo.

9.5 Organizaciones y Grandes Instalaciones

CEA : Commissariat à l'Energie Atomique, Francia.

$EBIT-II\ \ LLNL$: Electron Beam Ion Trap LLNL, California, USA.

$ITER$: International Thermonuclear Experimental Reactor, Francia.

$NIF\ \ LLNL$: National Ignition Facility, California, USA.

$LANL$: Los Alamos National Laboratory, New Mexico, USA.

LMJ : Laser Mégajoule, Francia.

$LLNL$: Lawrence Livermore National Laboratory, California, USA.

$LULI\ 2000$: Laboratoire pour l'Utilisation des Lasers Intenses, 2000 J facility, Francia.

SNL : Sandia National Laboratory, Albuquerque, New Mexico, USA.

$ULPGC\ /UPM$: Universidad Las Palmas de Gran Canaria / Universidad Politécnica de Madrid.

10. ANEXO II: MALLAS FINAS DE CALCULO COLISIONAL RADIATIVO

Tabla Anexo II: Extracto de Ionización media del hierro para una malla de temperaturas electrónicas (eV) y densidades electrónicas (cm^{-3})

Ne/Te	140	150	160	170	180	190
1.5E+22	1.562504E+01	1.577532E+01	1.590467E+01	1.602060E+01	1.613260E+01	1.624163E+01
2E+22	1.551169E+01	1.568706E+01	1.584368E+01	1.597578E+01	1.610508E+01	1.622909E+01
2.5E+22	1.539646E+01	1.560800E+01	1.577529E+01	1.592893E+01	1.606922E+01	1.620641E+01
3E+22	1.527392E+01	1.551843E+01	1.571372E+01	1.587877E+01	1.602910E+01	1.617822E+01
3.5E+22	1.518256E+01	1.542293E+01	1.564709E+01	1.582354E+01	1.599068E+01	1.614653E+01
4E+22	1.509631E+01	1.535176E+01	1.555060E+01	1.576762E+01	1.595053E+01	1.611251E+01
4.5E+22	1.501332E+01	1.528326E+01	1.551124E+01	1.570674E+01	1.590549E+01	1.607523E+01
5E+22	1.493524E+01	1.521718E+01	1.545639E+01	1.566168E+01	1.586008E+01	1.604718E+01
5.5E+22	1.485908E+01	1.515424E+01	1.540391E+01	1.562002E+01	1.581465E+01	1.601206E+01
6E+22	1.478726E+01	1.509257E+01	1.535243E+01	1.557958E+01	1.578168E+01	1.596597E+01
6.5E+22	1.471912E+01	1.503343E+01	1.530174E+01	1.553694E+01	1.574595E+01	1.593652E+01

Tabla Anexo II: Extracto de Opacidad frecuencial del hierro para la temperatura electrónica 190 (eV) y densidad electrónica 8.0E+22 (cm^{-3})

hnu(eV)	**K(cm2/g)**	**Kbb(cm2/g)**	**Kbf(cm2/g)**	**Kff(cm2/g)**
0.237500	4.401057E+09	6.273223E-01	0.000000E+00	2.059058E+09
0.475000	7.259798E+08	1.292664E+00	0.000000E+00	3.396535E+08
0.712500	2.555663E+08	1.997053E+00	0.000000E+00	1.195680E+08
…	…	…	…	…
1000.112500	5.538878E+03	2.534414E+03	5.486989E+01	2.056098E+00
1000.350000	5.549237E+03	2.539297E+03	5.483526E+01	2.054651E+00
1000.587500	5.559636E+03	2.544198E+03	5.480065E+01	2.053205E+00
…	…	…	…	…
5624000	1.137524E-01	2.370243E-08	1.248816E-07	3.050105E-11
5643000	1.137524E-01	2.354306E-08	1.234408E-07	3.021678E-11
5662000	1.137524E-01	2.338529E-08	1.220214E-07	2.993611E-11
5681000	1.137523E-01	2.322910E-08	1.206229E-07	2.965898E-11

Tabla Anexo II: Extracto de Ionización media del magnesio para una malla de temperaturas electrónicas (eV) y densidades electrónicas (cm^{-3})

Ne/Te	140	150	160	170	180	190
1.5E+22	9.881514E+00	9.918387E+00	9.945472E+00	9.966264E+00	9.983137E+00	9.997784E+00
2E+22	9.841996E+00	9.887684E+00	9.921387E+00	9.947220E+00	9.968013E+00	9.985778E+00
2.5E+22	9.803863E+00	9.857702E+00	9.897598E+00	9.928182E+00	9.952668E+00	9.973374E+00
3E+22	9.767095E+00	9.828511E+00	9.874234E+00	9.909321E+00	9.937320E+00	9.960811E+00
3.5E+22	9.731684E+00	9.800117E+00	9.851338E+00	9.890712E+00	9.922073E+00	9.948228E+00
4E+22	9.697435E+00	9.772495E+00	9.828924E+00	9.872388E+00	9.906970E+00	9.935687E+00
4.5E+22	9.664327E+00	9.745612E+00	9.806984E+00	9.854359E+00	9.892043E+00	9.923231E+00
5E+22	9.632279E+00	9.719477E+00	9.785507E+00	9.836631E+00	9.877305E+00	9.910880E+00
5.5E+22	9.601232E+00	9.693968E+00	9.764480E+00	9.819204E+00	9.862760E+00	9.898645E+00
6E+22	9.571115E+00	9.669093E+00	9.743882E+00	9.802065E+00	9.848411E+00	9.886537E+00
6.5E+22	9.541877E+00	9.644827E+00	9.723701E+00	9.785213E+00	9.834257E+00	9.874558E+00

Tabla Anexo II: Extracto de Opacidad media de Rosseland del magnesio para una malla de temperaturas electrónicas (eV) y densidades electrónicas (cm^{-3})

Ne/Te	140	150	160	170	180	190
1.5E+22	6.502E+01	4.640E+01	3.487E+01	2.746E+01	2.256E+01	1.924E+01
2E+22	8.273E+01	5.922E+01	4.452E+01	3.501E+01	2.867E+01	2.433E+01
2.5E+22	9.979E+01	7.168E+01	5.396E+01	4.242E+01	3.468E+01	2.935E+01
3E+22	1.163E+02	8.381E+01	6.322E+01	4.971E+01	4.061E+01	3.431E+01
3.5E+22	1.322E+02	9.564E+01	7.228E+01	5.689E+01	4.646E+01	3.921E+01
4E+22	1.476E+02	1.072E+02	8.118E+01	6.395E+01	5.223E+01	4.406E+01
4.5E+22	1.626E+02	1.185E+02	8.991E+01	7.092E+01	5.794E+01	4.886E+01
5E+22	1.771E+02	1.295E+02	9.849E+01	7.778E+01	6.358E+01	5.361E+01
5.5E+22	1.912E+02	1.402E+02	1.069E+02	8.455E+01	6.916E+01	5.832E+01
6E+22	2.049E+02	1.508E+02	1.152E+02	9.124E+01	7.468E+01	6.298E+01
6.5E+22	2.182E+02	1.611E+02	1.234E+02	9.783E+01	8.013E+01	6.761E+01

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