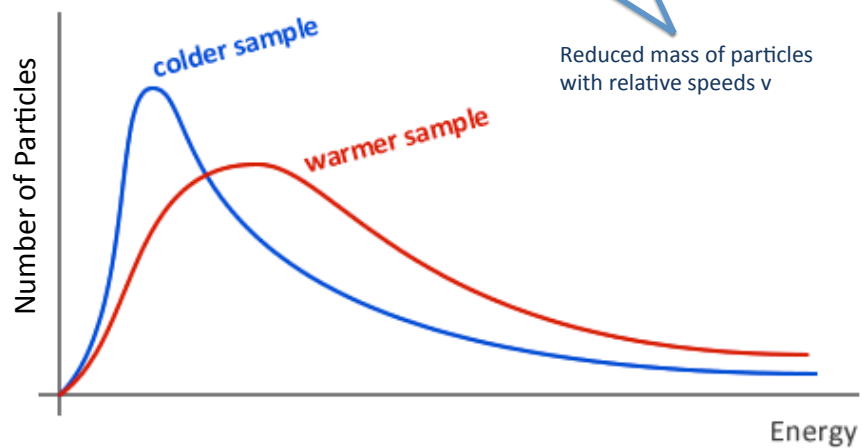


## Maxwell Boltzmann Distribution

$$f(v) = 4\pi \left[ \frac{m}{2\pi kT} \right]^{3/2} v^2 e^{-mv^2/2kT}$$



## Example Neutral (H or H<sub>2</sub>) Collision Rates

**Table 4.2.** Rate Coefficients (cm<sup>3</sup>s<sup>-1</sup>) for Deexcitation by H and H<sub>2</sub>

Temperature $T$ (°K)	10°	30°	100°	300°	1000°
$10^{11} \times \gamma_{kj}$ for H-H	0.23	3.0	9.5	16	25
$10^{10} \times \gamma_{kj}$ for H-C <sup>+</sup>	6.9	7.4	8.0	8.4	9.7
$10^{12} \times \gamma_{20}$ for H-H <sub>2</sub>	0.96	1.37	3.0	9.1	42
$10^{11} \times \gamma_{10}$ for H <sub>2</sub> -CO	1.8	3.2	3.7		

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# Table of Collision Strengths with e<sup>-</sup>

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EXCITATION

**Table 4.1.** Collision Strengths for Excitation by Electrons

Number of <i>p</i> electrons	Ion	Levels		$E_{jk}$ (eV)	$\Omega(j, k)$	$\Sigma_j A_{kj} (s^{-1})$
		Lower	Upper			
1,5	C II	$^2P_{1/2}$	$^2P_{3/2}$	0.0079	1.33	$2.4 \times 10^{-6}$
	Ne II	$^2P_{3/2}$	$^2P_{1/2}$	0.097	0.37	$8.6 \times 10^{-3}$
	Si II	$^2P_{1/2}$	$^2P_{3/2}$	0.036	7.7	$2.1 \times 10^{-4}$
2	N II	$^3P_0 - ^3P_1$		0.0061	0.41	$2.1 \times 10^{-6}$
		$^3P_0 - ^3P_2$		0.0163	0.28	$7.5 \times 10^{-6}$
		$^3P_1 - ^3P_2$		0.0102	1.38	$7.5 \times 10^{-6}$
		$^3P - ^1D_2$		1.90	2.99	$4.0 \times 10^{-3}$
		$^3P - ^1S_0$		4.05	0.36	1.1
	O III	$^3P_0 - ^3P_1$		0.014	0.39	$2.6 \times 10^{-5}$
		$^3P_0 - ^3P_2$		0.038	0.21	$9.8 \times 10^{-5}$
		$^3P_1 - ^3P_2$		0.024	0.95	$9.8 \times 10^{-5}$
		$^3P - ^1D_2$		2.51	2.50	$2.8 \times 10^{-2}$
3	O II	$^3P - ^1S_0$		5.35	0.30	1.8
		$^4S_{3/2} - ^2D_{5/2}$		3.32	0.88	$4.2 \times 10^{-5}$
		$^4S_{3/2} - ^2D_{3/2}$		3.32	0.59	$1.8 \times 10^{-4}$
		$^2D_{3/2} - ^2D_{5/2}$		0.0025	1.16	$4.2 \times 10^{-5}$

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## Leiden Collision Rate Database

home.stw.leidenuniv.nl/~moldata/

Getting Started | Homepage | Gmail | Google+ | Voice | Maps | Facebook | News | Orbitz | ADS | Astro-ph

### LAMDA

Leiden Atomic and Molecular Database

[Atomic datafiles](#) | [Molecular datafiles](#) | [Data format](#) | [RADEX](#)

**Atomic datafiles**  
C C<sup>+</sup> O

**Molecular datafiles**  
CO CS HCl  
OCS SO SO<sub>2</sub>  
SiO SiS SiC<sub>2</sub>  
HCO<sup>+</sup> N<sub>2</sub>H<sup>+</sup> HCS<sup>+</sup>  
HC<sub>2</sub>N HCN HNC  
C<sub>2</sub>H<sub>2</sub> H<sub>2</sub>O H<sub>2</sub>CO  
OH CH<sub>3</sub>OH NH<sub>3</sub>  
HDO H<sub>3</sub>O<sup>+</sup> HNGO  
NO CN CH<sub>3</sub>CN  
O<sub>2</sub> HF H<sub>2</sub>S  
H<sub>2</sub>CS

**Radiative transfer**  
RADEX Benchmarking

**Development**  
Update history  
Future updates

The aim of this project is to provide users of radiative transfer codes with the basic atomic and molecular data needed for the excitation calculation. Line data of a number of astrophysically interesting species are summarized, including energy levels, statistical weights, Einstein A-coefficients and collisional rate coefficients. Available collisional data from quantum chemical calculations and experiments are in some cases extrapolated to higher energies.

Currently the database contains data for 3 atomic and 29 molecular species. In addition, several isotopomers and deuterated versions are available. Work is currently underway to add more datafiles. We encourage comments from the users in order to improve and extend the database.

This database should form an important tool in analyzing observations from current and future infrared and (sub)millimetre telescopes. Databases such as these rely heavily on the efforts by the chemical physics community to provide the relevant atomic and molecular data. We strongly encourage further efforts in this direction, so that data for more species become available and the current extrapolations of collisional rate coefficients can be replaced by actual calculations in future releases.

RADEX, a computer program for performing statistical equilibrium calculations is made publically available as part of the data base.

For new or changed datafiles, see the [update history](#) or follow us on [Twitter](#).

If you use the data files in your work please refer to the [publication](#) by Schöier, F.L., van der Tak, F.F.S., van Dishoeck E.F., Black, J.H. 2005, *A&A* 432, 369-379 introducing this data base. When individual molecules are considered, references to the original papers providing the spectroscopic and collisional data are encouraged.