Argon as Target Gas

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Motivation

Nitrogen offers the strongest signal but the photons originate from molecular ions which during the relatively long life time of the upper level have a complicated dynamics due to the beam and solenoid fields.

Neon’s emission, while relatively strong and originating from the neutral atom, lies at wavelengths around 600 nm, where the sensitivity of the detection chain is low.

Recently Argon has been proposed as an alternative. Here we give a first account on optical emission cross sections and the resulting spectral range of interest.

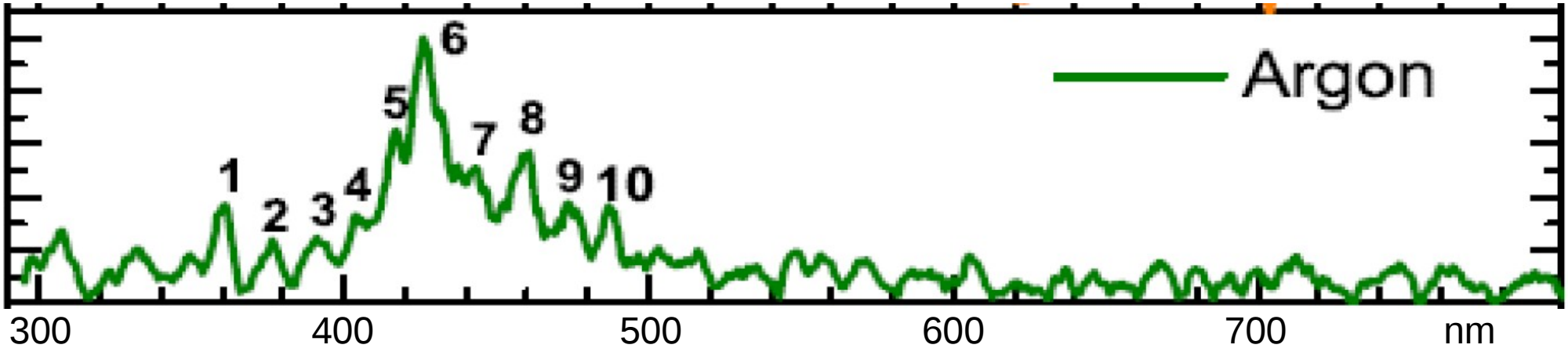
Excitation by electrons

Most of the data available at low electron energies. The article of J.B. Boffard, B. Chiaro, T. Weber and C.C. Lin in “Atomic Data and Nuclear Data Tables” vol. 93 (2007) p. 831 gives a very good overview of the emission cross sections in the spectral range 300 – 2500 nm for electron energies up to 250 eV. Here we present a list of the lines with cross sections of at least 10^{-19} cm² at an incident electron energy of 100 eV. Just the spectral range 300 – 600 nm was taken into consideration.

Wavelength [nm]	Source	Life time [ns]	Cross section [cm²]
405.29	Ar^+	14.9	$1.3 \cdot 10^{-19}$
407.20	Ar^+	17.2	$1.4 \cdot 10^{-19}$
413.17	Ar^+	11.8	$2.0 \cdot 10^{-19}$
419.83	Ar	384	$2.0 \cdot 10^{-19}$
425.94	Ar	294	$2.1 \cdot 10^{-19}$
427.22	Ar	1250	$1.3 \cdot 10^{-19}$
427.75	Ar^+	12.5	$3.6 \cdot 10^{-19}$
434.81	Ar^+	8.5	$1.2 \cdot 10^{-19}$
442.60	Ar^+	12.2	$1.3 \cdot 10^{-19}$
454.51	Ar^+	21.3	$3.2 \cdot 10^{-19}$
457.93	Ar^+	12.5	$1.0 \cdot 10^{-19}$
458.99	Ar^+	15.2	$1.9 \cdot 10^{-19}$
460.96	Ar^+	12.7	$3.2 \cdot 10^{-19}$
465.79	Ar^+	11.2	$2.3 \cdot 10^{-19}$
472.69	Ar^+	16.9	$1.8 \cdot 10^{-19}$
476.49	Ar^+	15.6	$4.5 \cdot 10^{-19}$
487.99	Ar^+	12.2	$2.9 \cdot 10^{-19}$
496.51	Ar^+	25.6	$1.1 \cdot 10^{-19}$

NOTE: The emission cross section for the Neon line at 585.4 nm is approx. 10^{-18} cm² for the same incident electron energy

Emission spectrum due to protons



Spectrum obtained at GSI with 4.757 MeV protons

Preliminary conclusions

Argon emission cross sections are smaller than those for Neon

Integration over the spectral range 400 – 500 nm recommended; in this region the detection chain is more sensitive than for Neon (factor of 2)

Strongest emission in the region of interest comes from Ar^+

Since Argon is heavier than Nitrogen and the life times of the upper levels are mostly much smaller profile distortion is expected to be acceptable