Analysis of Digital Meteor Spectra

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The observed spectrum is a superposition of two spectra:

- **Main spectrum (head)** - 4000 - 5000 K
  - Fe I, Mg I, Ca I, Ca II, Al I, Ti I, Mn I, Cr I, Na I
- **Second spectrum (shock-wave)** - ~ 10000 K
  - Fe II, Ca II, Mg II, Ti II, Si II

The second spectrum is present only in fast meteors. Observed line profiles are instrumental.

Synthetic spectrum \(\rightarrow\) Voigt function
Voigt profile: Gaussian factor

$\text{Sigma} = 1, \text{Gamma} = 0.5$
Voigt profile: Gaussian factor

Sigma = 2, Gamma = 0.5
Voigt profile: Gaussian factor

\[ \text{Sigma} = 3, \text{Gamma} = 0.5 \]
Voigt profile: Gaussian factor

Sigma = 4, Gamma = 0.5
Voigt profile: Gaussian factor

Sigma = 5, Gamma = 0.5
Voigt profile: Lorentz factor

Sigma = 1.0, Gamma = 0.1
Voigt profile: Lorentz factor

Sigma = 1.0, Gamma = 0.2
Voigt profile: Lorentz factor

Sigma = 1.0, Gamma = 0.3
Voigt profile: Lorentz factor

Sigma = 1.0, Gamma = 0.4
Voigt profile: Lorentz factor
Voigt profile: Lorentz factor

Sigma = 1.0, Gamma = 0.6
Voigt profile: Lorentz factor

Sigma = 1.0, Gamma = 0.7
Voigt profile: Lorentz factor
Voigt profile: Lorentz factor

Sigma = 1.0, Gamma = 1.0
Analogue cameras.

SDAFO = Spectral Digital Autonomous Fireball Observatory
Equipment: Analogue vs. digital (Canon EOS 6D)

- focal length of 360mm
- 1:4.5 focal ratio
- 180 x 240 mm photo-plate
- resolution 23957 x 17967 px
- 15.2 rotations/s shutter
- 600 grooves/mm grating
- limiting magnitude \( \sim -6 \)
- Whole night exposure time
- dispersion 0.45 Å/pixel
- spectral range 3500 - 6600 Å
  \((\text{FOV} \sim 25^\circ \times 40^\circ) \times 6\)
- working from 1960 to 2018
- 240 recorded spectra

- focal length of 15mm
- 1:2.8 focal ratio
- 35.8 x 23.9 mm sensor size
- resolution 5472 x 3648 px
- no shutter
- 1000 grooves/mm grating
- limiting magnitude \( \sim -7 \)
- exposure time of 30s
- dispersion 4 Å/pixel
- spectral range 3700 - 9000 Å
  \((\text{FOV} \sim 100^\circ \times 140^\circ) \times 2\)
- working since 2015
- 670 recorded spectra
### Equipment: Analogue vs. digital (Canon EOS 6D)

<table>
<thead>
<tr>
<th>Analogue Equipment</th>
<th>Digital Equipment</th>
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<tbody>
<tr>
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Obtaining the spectrum from the image
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Obtaining the spectrum from the image

Astrometry and photometry using FishScan.
"Scanning" the spectrum using FishScan.
Obtaining the spectrum from the image

Digital spectrum with background.
Digital spectrum (calibrated)

Intensity calibrated digital spectrum.
Analogue spectrum (calibrated)

Intensity calibrated digital spectrum.
Analysing the spectrum

- Originally analysis by parts in separate software
  - Wavelength calibration
  - Spectral sensitivity calibration
  - Synthetic fit of the spectrum
  - Wavelength dependencies of the fit parameters
  - Continuum identification
  - Physical fit of the spectrum
  - Comparison with other spectra
  - **Intensity correction for position in FoV**

- New semi-automated approach using SynthFit software
FoV intensity correction (motivation)
FoV intensity correction (motivation)
FoV intensity correction (lab spectra)
FoV intensity correction (lab spectra)
FoV intensity correction: Wavelength correction

Wavelength calibrated spectra
FoV intensity correction: Wavelength segments
FoV intensity correction: Line intensities
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FoV intensity correction: Line intensities
FoV intensity correction: Line intensities
FoV intensity correction: Uncorrected
FoV intensity correction: Corrected

Intensity corrected spectra for FoV position

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FoV intensity correction: Corrected
Analysing the spectrum: Loading the spectrum
Analysing the spectrum: Loading theoretical lines
Analysing the spectrum: Identifying profiles
Analysing the spectrum: Automatic rough fit
Analysing the spectrum: Accounting for overlap
Analysing the spectrum: Manual adjustments
Analysing the spectrum: Wavelength calibration
Analysing the spectrum: Selecting best fit degree
Analysing the spectrum: Spectral sensitivity calibration
Analysing the spectrum: Gaussian factor parametrization

Figure 1

Gaussian width functional fit (man)

- Gaussian width in
- Gaussian width out
- Manual fit (applied)

- Intensity calibrated (ADC)
- Synthetic fit (Radii)
- Relative intensity

Wavelength [Å]

Intensity [10^7 erg/s/ster]
Analysing the spectrum: FoV intensity correction
Analysing the spectrum: Physical fit
Analysing the spectrum: Physical fit
Analysing the spectrum: Physical fit
Current status

✓ Partial automation of the analysis process
✓ Wavelength calibration
✓ Lorentz and Gaussian factor dependency on wavelength
✓ Continuum identification
✓ Differences in spectra with different FOV geometry
✓ Physical fit of the spectrum
✗ Spectral sensitivity
✗ Ionization correction

