Calibrated Photometry

Orlagh Creevey (OCA-Lagrange)

Photometric data processing

- Data reduction: bias, flat, dark
- Correction for atmospheric extinction
- Transformation to standard system
- Heliocentric corrections

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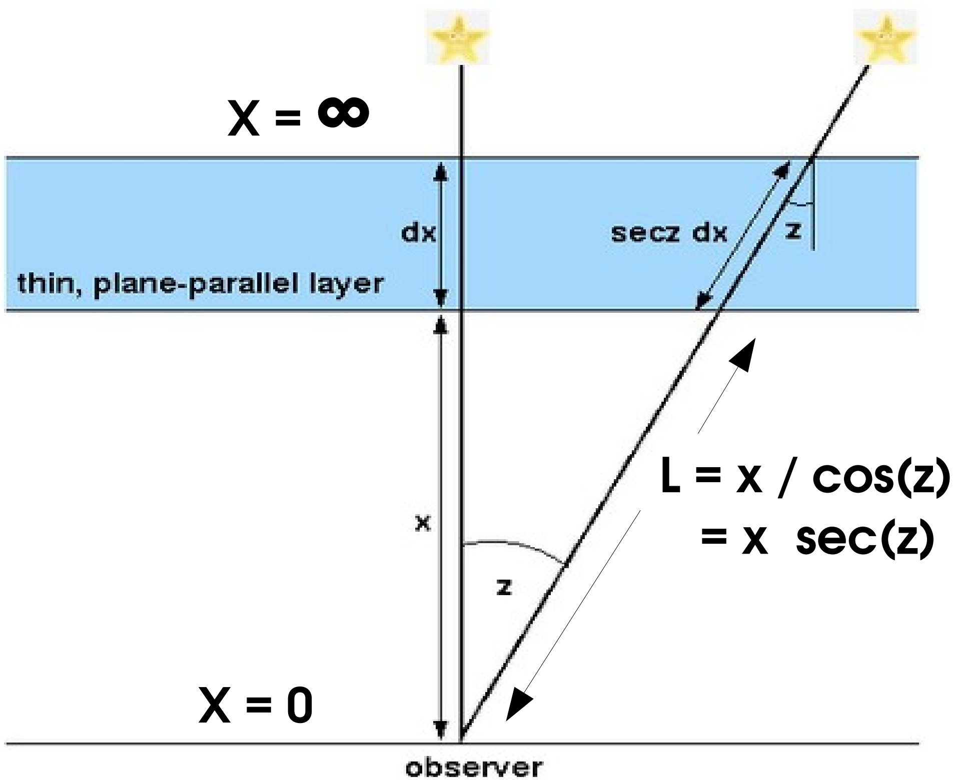
Atmospheric Extinction

- Absorption and scattering of electromagnetic radiation
- Interstellar, circumstellar, atmospheric
- Atmospheric:
  - Rayleigh scattering
  - Molecular absorption
  - Aerosols, Dust, volcanic ash, climate, altitude
- Impact is to attenuate the radiation ($dF_\lambda = - \alpha F_\lambda$)

Atmospheric Extinction

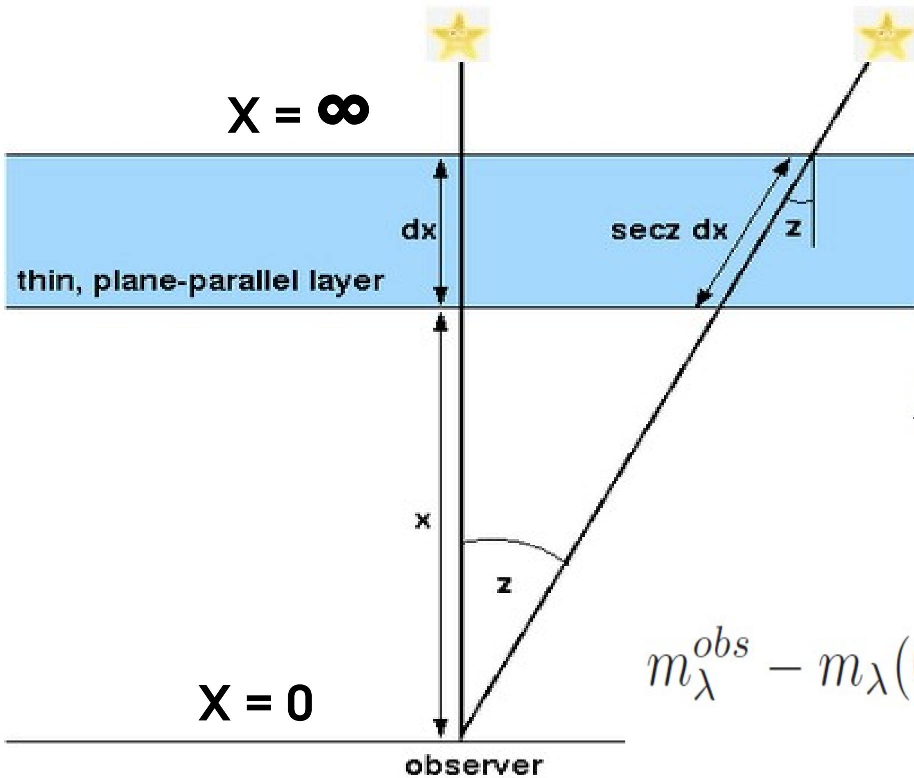


As light passes through each layer of thickness dl, its flux is reduced by

$$dF_\lambda = -\alpha F_\lambda \, dl$$

where α is the coefficient of atmospheric extinction.

Atmospheric Extinction



$$dF_\lambda = -\alpha F_\lambda \, dl$$

With some simple math manipulation we end up with

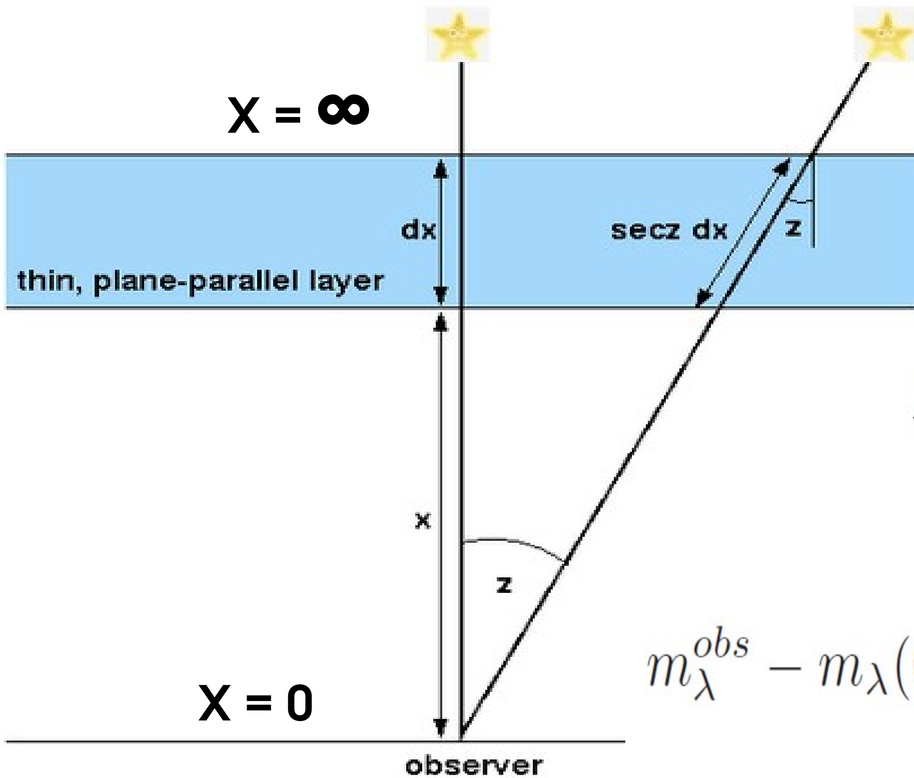
$$I_\lambda(x=0) = I_\lambda(x=\infty)\; e^{-\ sec(z) K'_\lambda}$$

Which becomes

$$m_\lambda^{obs} - m_\lambda(0) = 1.086\,\sec(z)\; K'_\lambda \equiv \sec(z) K_\lambda \equiv X K_\lambda$$

With K_λ the coefficient of ext.

Atmospheric Extinction



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$$m_\lambda^{obs} = m_\lambda(0) + K_\lambda X$$

Solving for Atmospheric Extinction

- m_λ^{obs} = instrumental mag.
- m_λ^{obs} (0)= instr. mag. corrected for extinction
- K_λ= coefficient of extinction
- X = airmass
- Observe a star several times at different airmasses we can solve this linear equation to determine m_λ^{obs} (0) and K_λ

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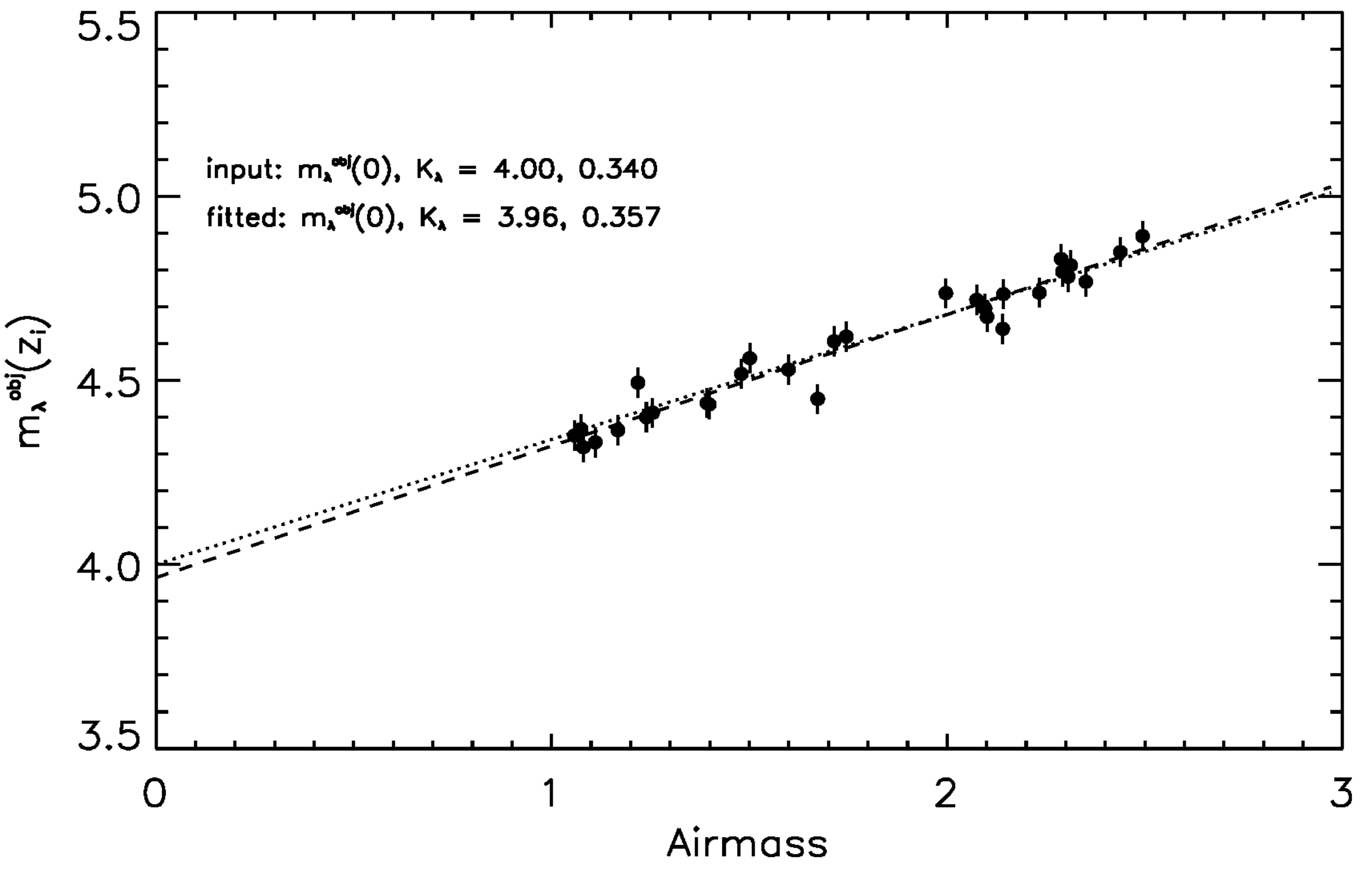
Solving for Atmospheric Extinction



Transformation of instrumental magnitudes to Standard

- Applying the same methodology to a standard calibration star we obtain

$$m_\lambda^{std} = m_\lambda^{std}(0) + K_\lambda X$$

- We then have

$$m_\lambda^{obj}(0) - m_\lambda^{std}(0) = m_\lambda^{cal,obj}(0) - m_\lambda^{cal,std}(0)$$

$$m_\lambda^{cal,obj} = m_\lambda^{cal,std} + [m_\lambda^{obj}(0) - m_\lambda^{std}(0)]$$

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Obtained from catalogues

Derived from previous section

Notes

- We suppose that the conditions are stable
- It is usual that we need to apply second or third order terms because of a colour dependence
- Filters are not identical and the response of the full system is almost never identical and depends on the colours
- For a more complete analysis, resolve a system of equations to cover the full range of observed colours and in various filters