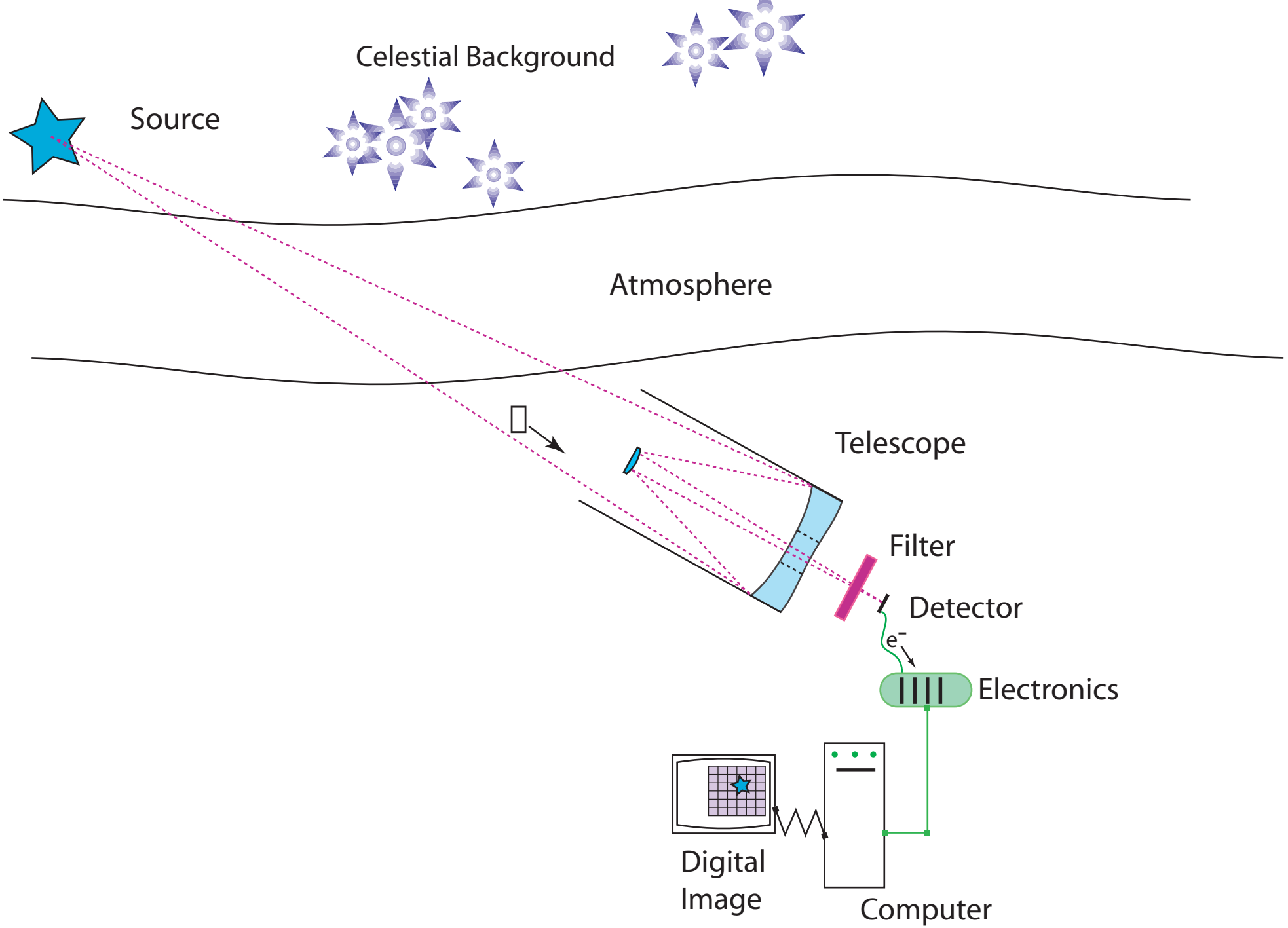
Supernova Photometry - Lecture 1

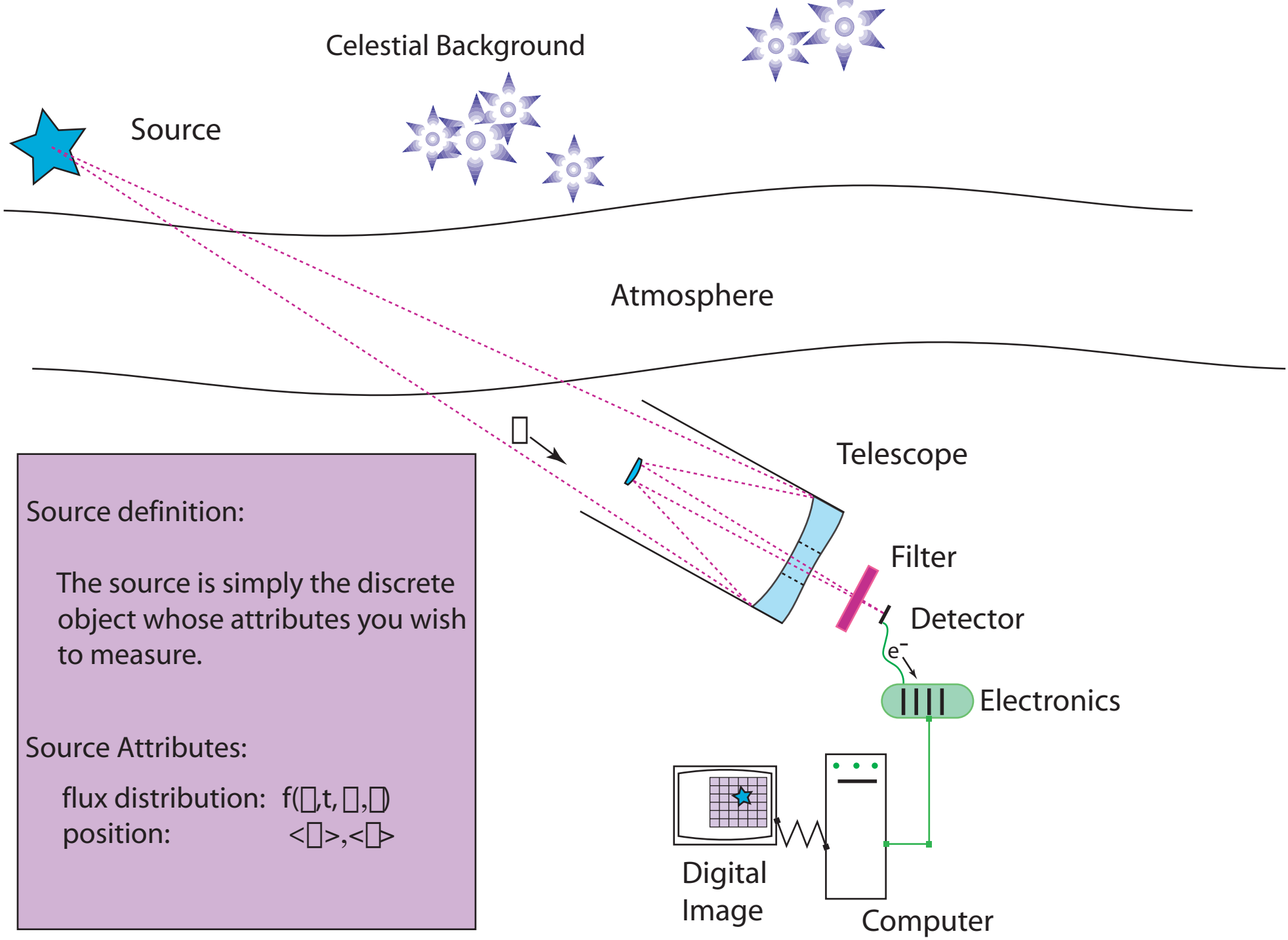
The Photometry Signal Chain

LBL Photometry Group Meeting

Feb 9, 2004

presented by Greg Aldering


Celestial Background
Source
Atmosphere
Telescope
Filter
Detector
e⁻
Electronics
Digital
Image
Computer

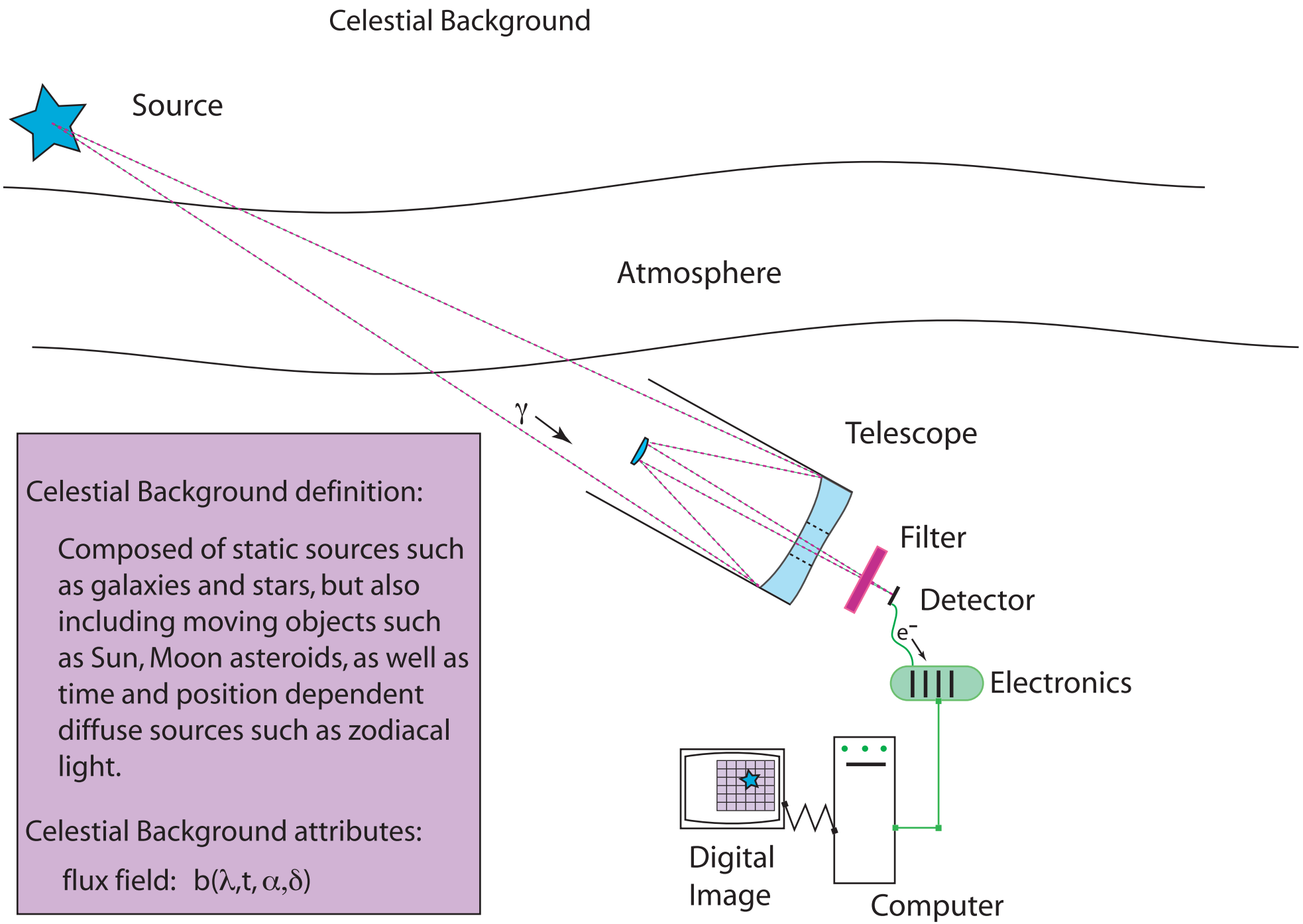


Source definition:

The source is simply the discrete object whose attributes you wish to measure.

Source Attributes:

flux distribution: f(□,t,□,□)
position: <□>,<□>

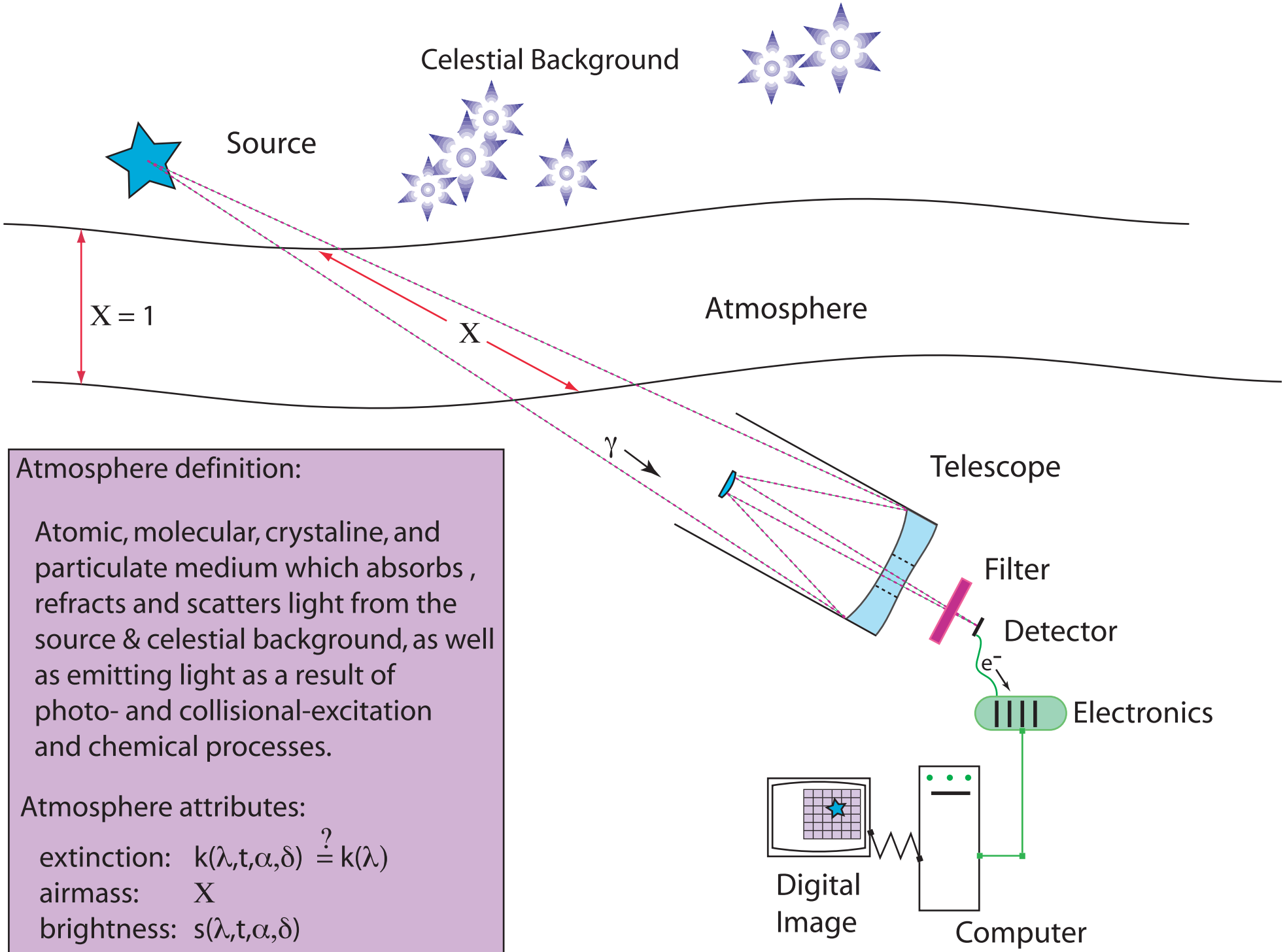


Celestial Background definition:

Composed of static sources such as galaxies and stars, but also including moving objects such as Sun, Moon asteroids, as well as time and position dependent diffuse sources such as zodiacal light.

Celestial Background attributes:

flux field: $b(\lambda, t, \alpha, \delta)$

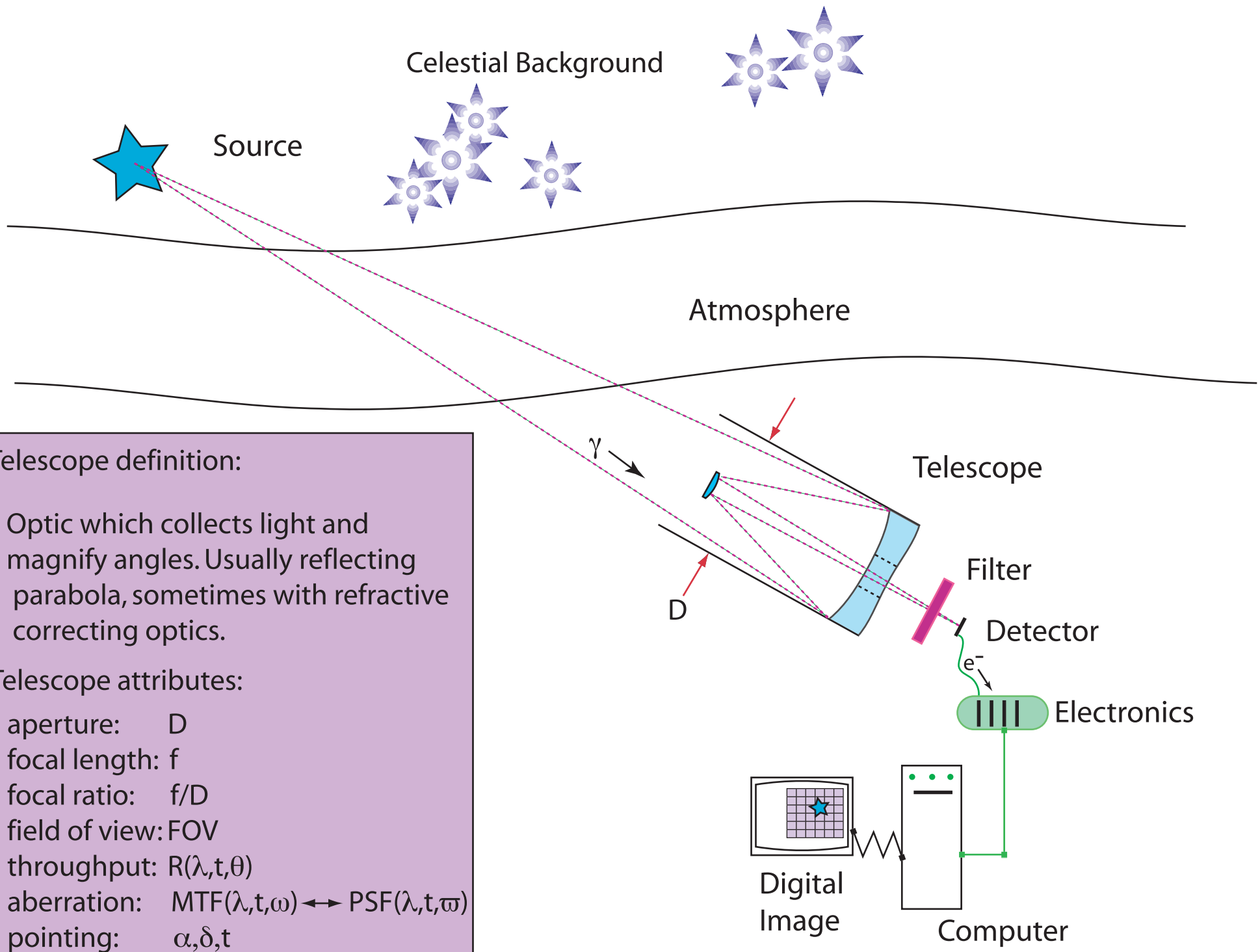


Atmosphere definition:

Atomic, molecular, crystaline, and particulate medium which absorbs , refracts and scatters light from the source & celestial background, as well as emitting light as a result of photo- and collisional-excitation and chemical processes.

Atmosphere attributes:

extinction: $k(\lambda,t,\alpha,\delta) \stackrel{?}{=} k(\lambda)$
airmass: X
brightness: $s(\lambda,t,\alpha,\delta)$
distortion: $MTF(\lambda,t,\omega) \leftrightarrow PSF(\lambda,t,\varpi)$

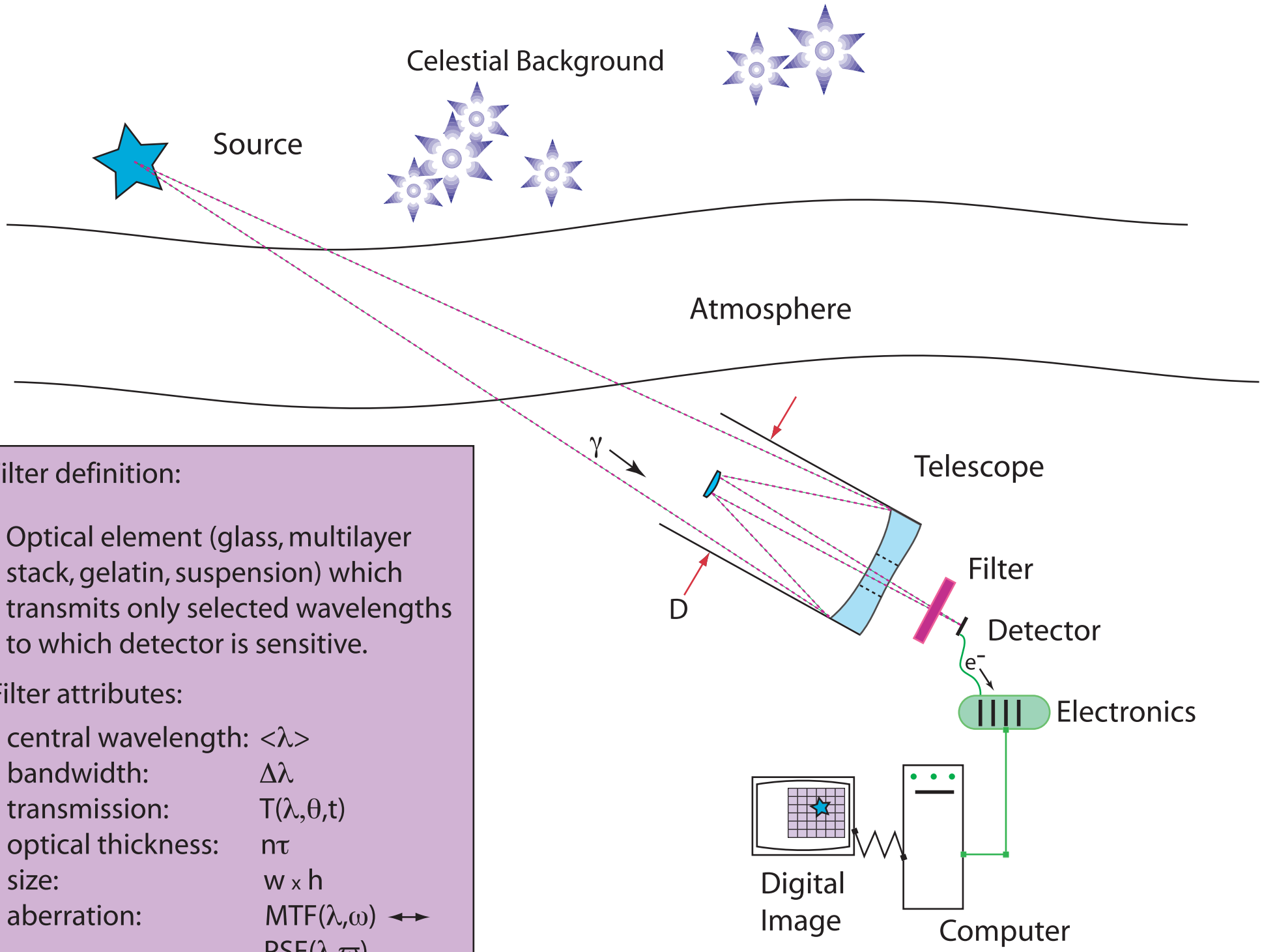


Telescope definition:

Optic which collects light and magnify angles. Usually reflecting parabola, sometimes with refractive correcting optics.

Telescope attributes:

aperture:	D
focal length:	f
focal ratio:	f/D
field of view:	FOV
throughput:	$R(\lambda,t,\theta)$
aberration:	$MTF(\lambda,t,\omega) \leftrightarrow PSF(\lambda,t,\varpi)$
pointing:	α,δ,t
distortion:	$Jacobian(\alpha,\delta,x,y)$



Filter definition:

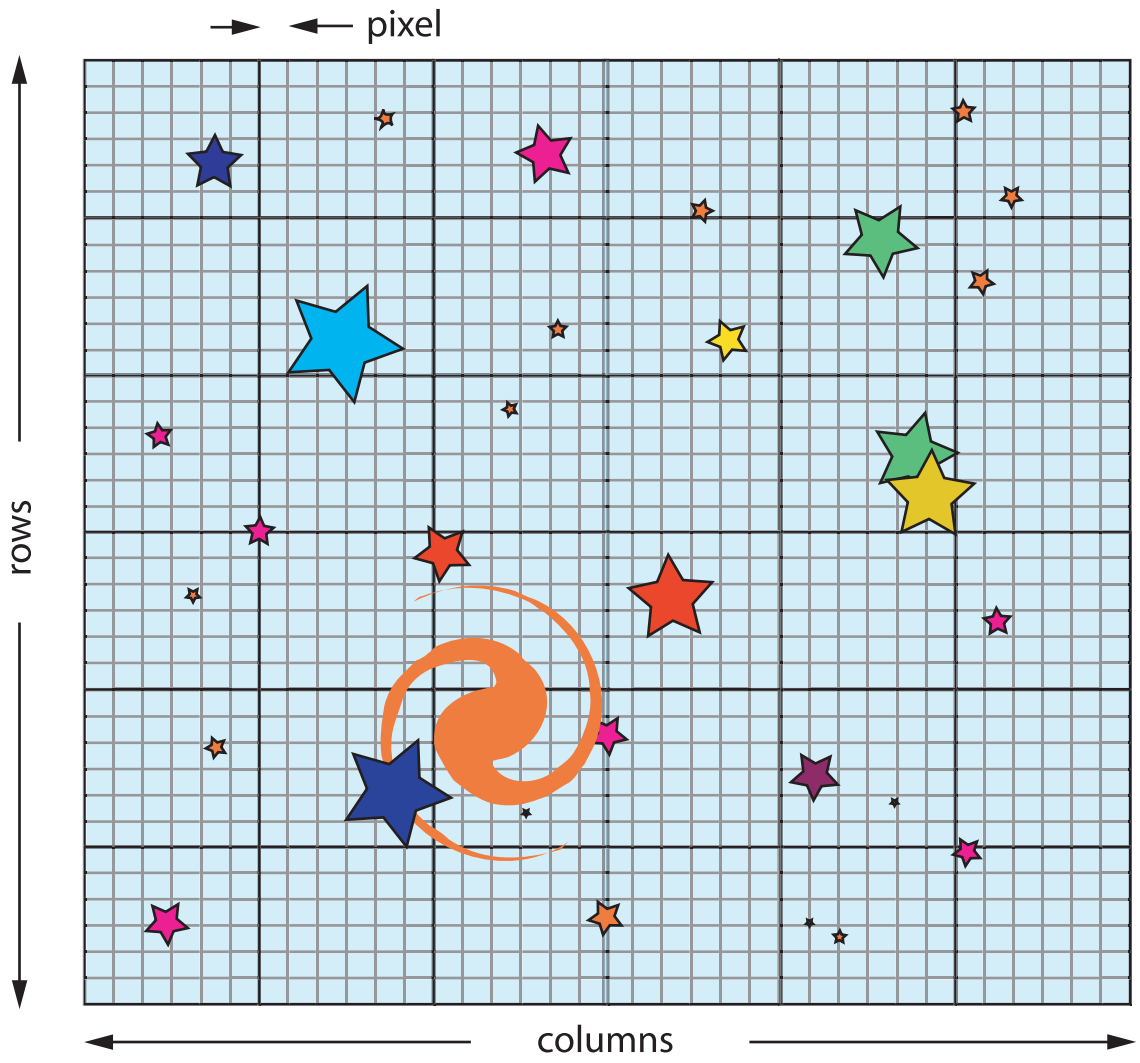
Optical element (glass, multilayer stack, gelatin, suspension) which transmits only selected wavelengths to which detector is sensitive.

Filter attributes:

central wavelength:	$\langle\lambda\rangle$
bandwidth:	$\Delta\lambda$
transmission:	$T(\lambda,\theta,t)$
optical thickness:	$n\tau$
size:	$w \times h$
aberration:	$MTF(\lambda,\omega)$ ↔
	$PSF(\lambda,\varpi)$

CCD detector attributes:

efficiency:	QE(λ,r,c)
dark current:	D(T,r,c)
bias:	B(r,c)
fringing:	F(λ,r,c)
charge transfer:	CTE
gain:	μV/e-
readout noise:	RON
well depth:	Cmax
diffusion:	MTF(x',y')
persistance:	C(t/τ)
amplifiers:	usually 1-4
defects:	bad columns, hot pixels, traps



Electronics attributes:

gain:	ADU/□V
A/D range:	e.g., 16 bits
readout speed:	e.g., 100 kpix/s
noise/pickup:	e.g., 60 Hz
ghosts:	response to bright object in another amp

Computer attributes:

data format:	e.g., FITS
data scaling:	e.g., BSCALE, BZERO
data type:	e.g. raw data are signed/unsigned 16 bit while processed data are 32 floating or truncated 16 bit integer