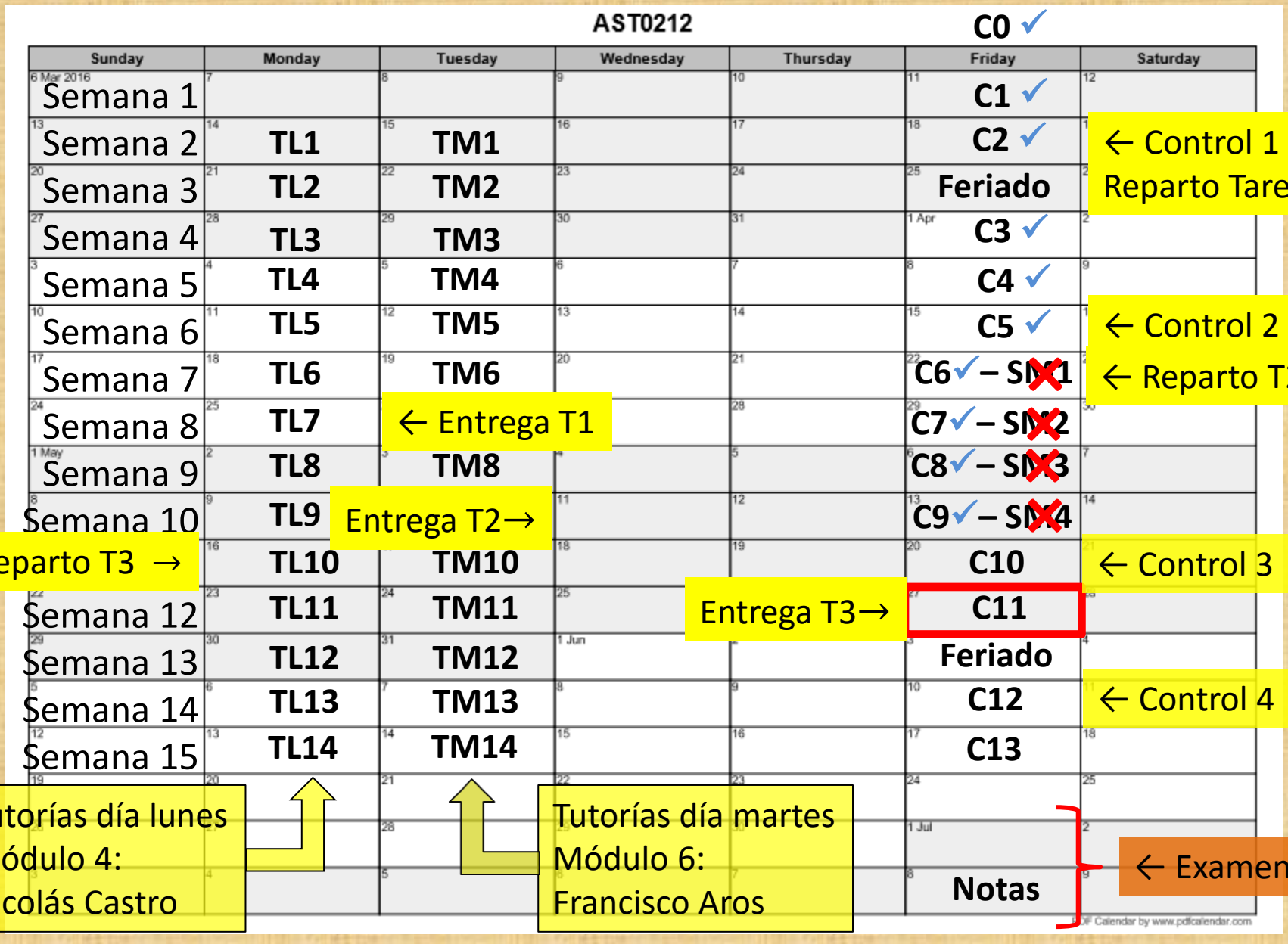

AST0212 – 2016-1
Introducción al análisis de datos
Instituto de Astrofísica
Facultad de Física
Pontificia Universidad Católica de Chile
©Albie Venter

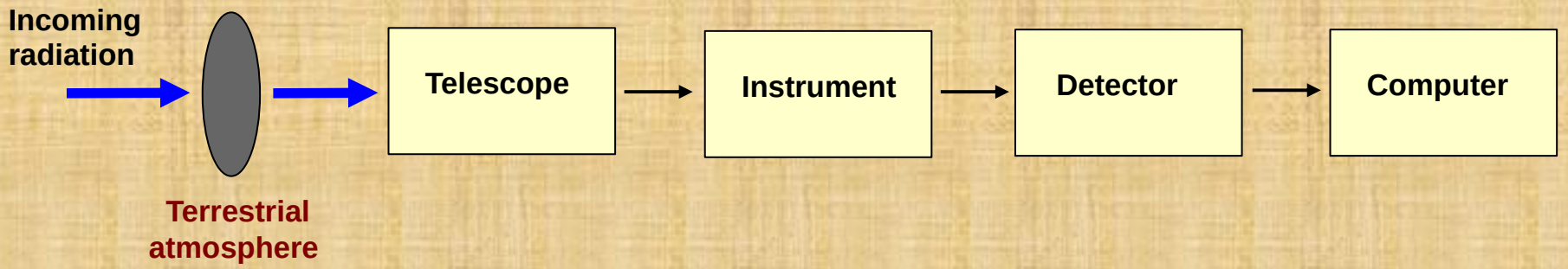
Nuestro Semestre 2016-1



Esta clase (Clase 11):

1. Imágenes Astronómicas

Structure of an **observing system**



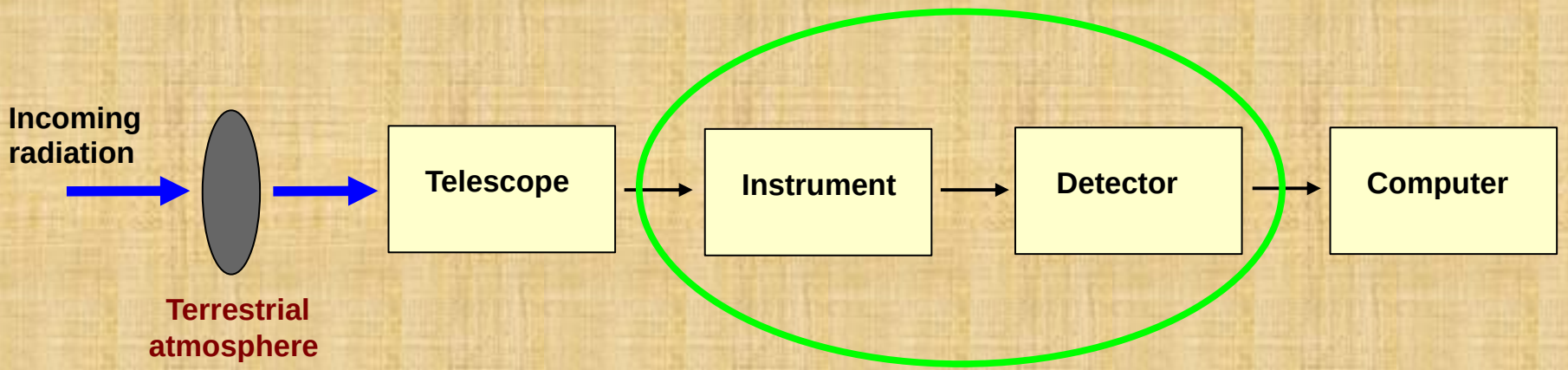
The **Telescope** has the purpose of collecting as much light as possible from the source, and of separating the light from nearby sources on the sky.

The **Instrument** has the purpose of forming an image or a spectrum, isolating photons of a given range of wavelengths. It is usually an imaging camera or a spectrograph.

The **Detector** (usually an optical CCD or a near-IR array) records and counts the photons that pass through the telescope + instrument.

The **Computer** controls the telescope & detector and stores the collected information.

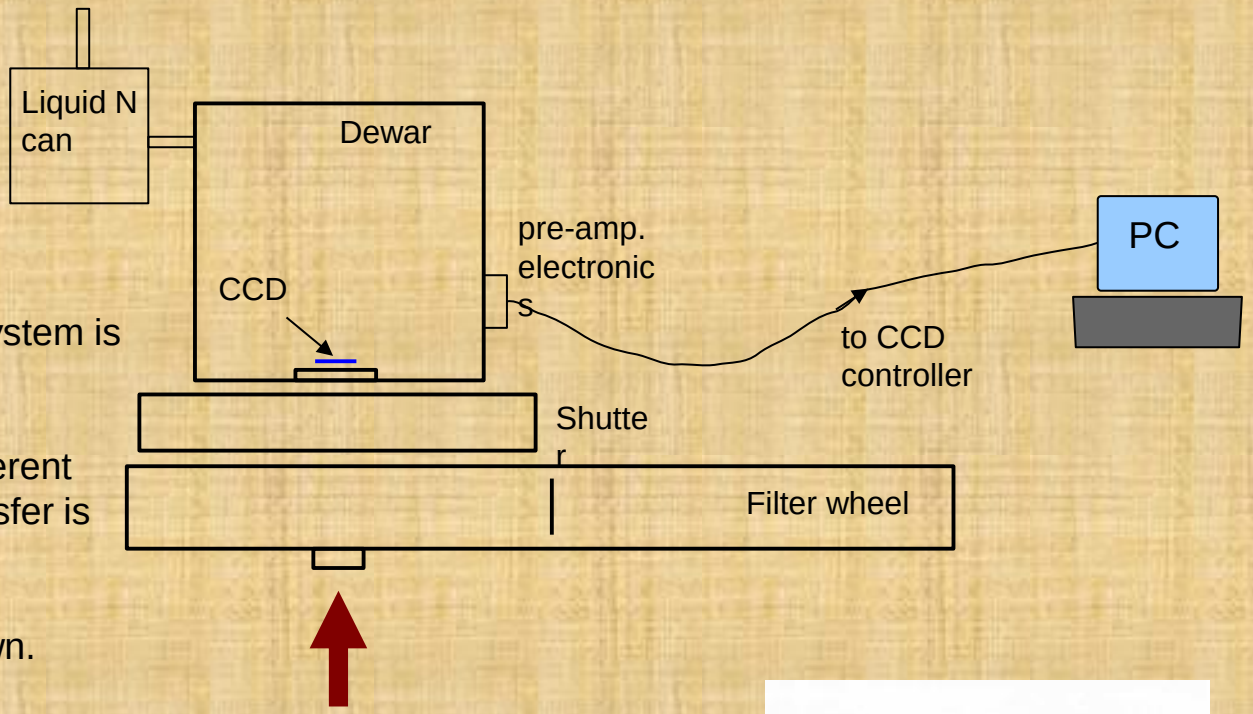
Structure of an **observing system**



The **Instrument** has the purpose of forming an image or a spectrum, isolating photons of a given range of wavelengths. It is usually an imaging camera or a spectrograph.

The **Detector** (usually an optical CCD or a near-IR array) records and counts the photons that pass through the telescope + instrument.

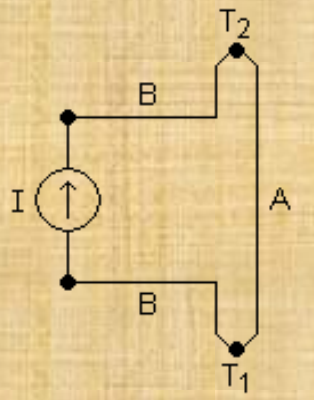
Most simple instrument: Imaging Camera



In our camera (ST-7) the cooling system is based on the Peltier effect:

When current passes from two different semiconductors A and B, heat transfer is produced at the junctions.

T_2 heats up and T_1 cools down.



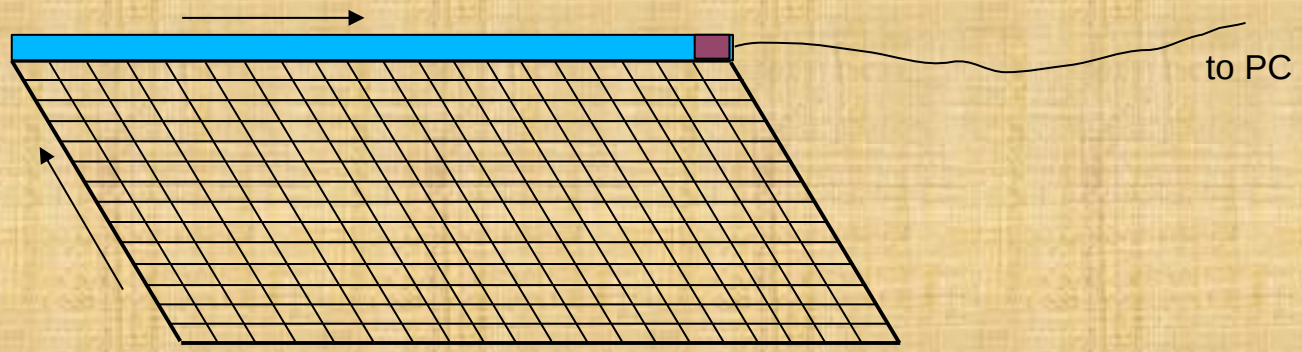
Our ST-7 camera

Picture of a CCD Detector: (one of the 8 IMACS CCDs at Magellan Telescope)

Modern Astronomical Detectors: Charged Coupled Devices (CCD)

A CCD is a Digital Detector very similar to that of commercial Digital Photographic Cameras.
It consist of an integrated circuit containing an array of pixels (*capacitors*), each one sensitive to photons, each one capable of recording how many photons have hit it.

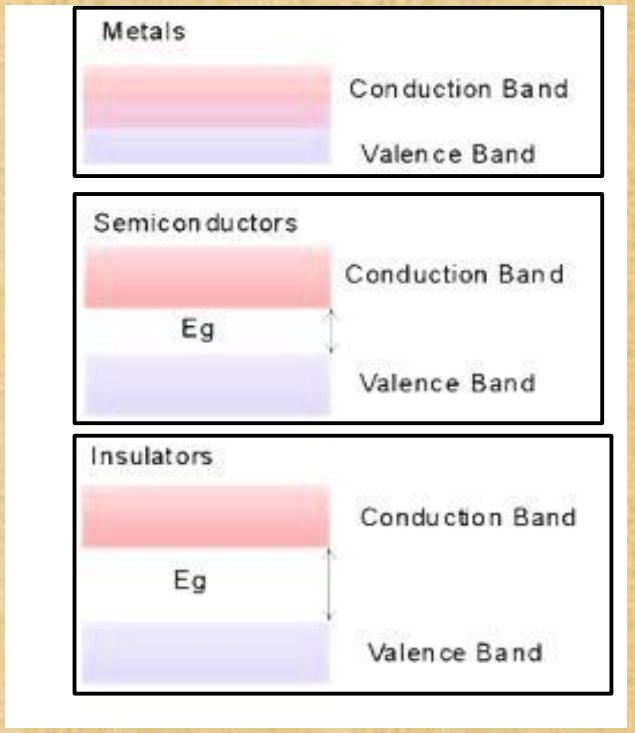
VERY schematic view of a CCD



The size of a CCD is normally ~ 1–4 cm per side, and they normally have between ~ 1000 – 4000 pixels per side (each pixel is then 10–20 microns large).

The physics of a CCD:

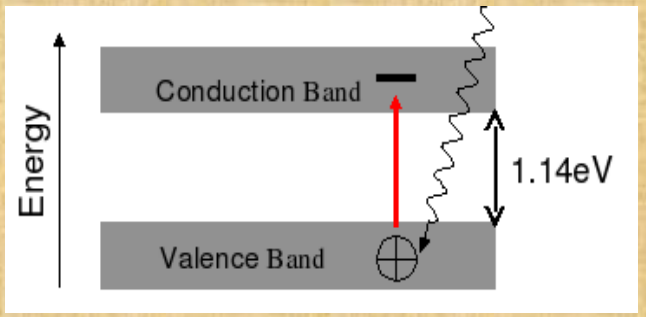
SEMICONDUCTOR: material whose valence electrons cannot move (conduct) between one atom and the next. However, if the electrons acquire some extra energy, they can jump to the *conduction band*, where they can be transfered from one atom to the next one.
This extra-energy can be provided by a photon.



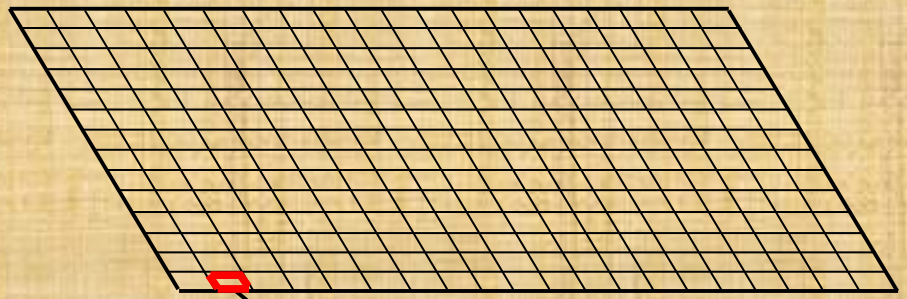
DOPING OF A SEMICONDUCTOR:
The electric properties of a semiconductor can be altered by adding some atoms to them.

n doping: atoms with more than 4 valence electrons are added. The extra electrons occupy the conduction band, creating a persistent set of negative charges.

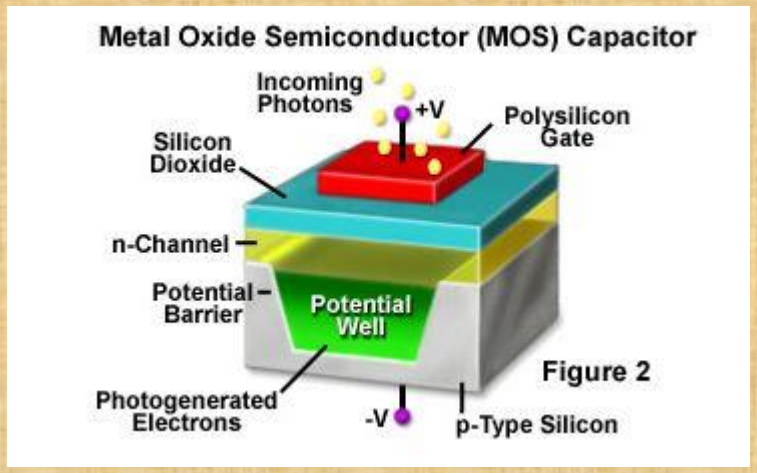
p doping: atoms with less than 4 valence electrons are added. Electrons from the conducting bands go to occupy the extra *holes* in the valence band. This creates a persistent set of positive charges.

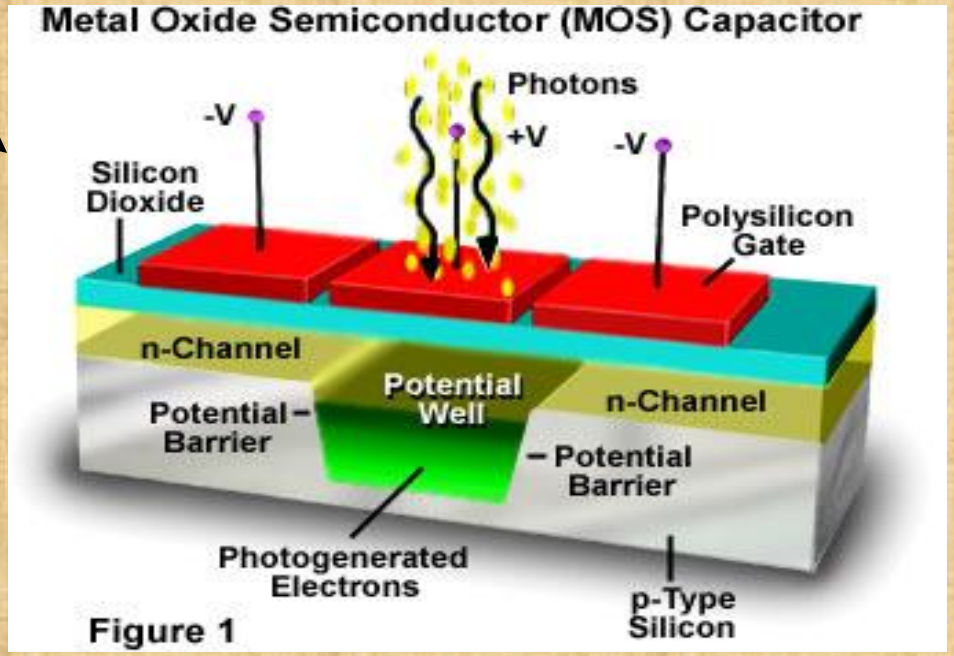


Modern Astronomical Detectors: Charged Coupled Devices (CCD)

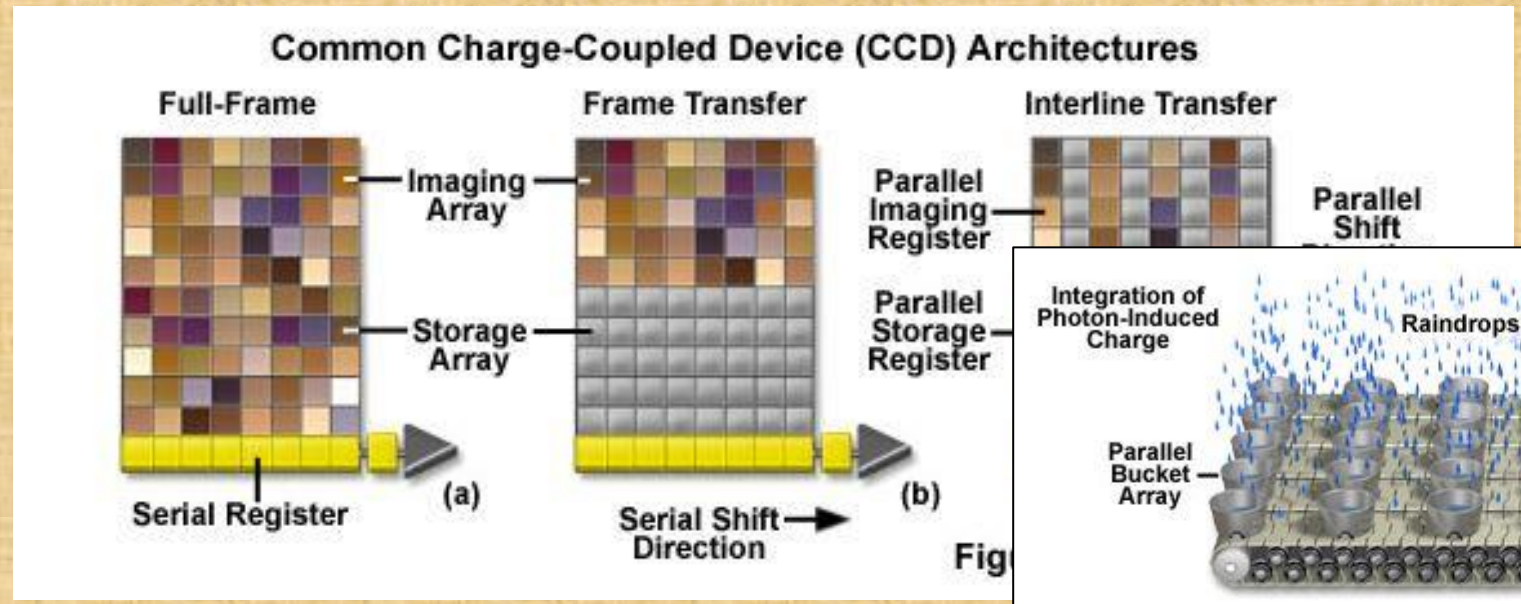


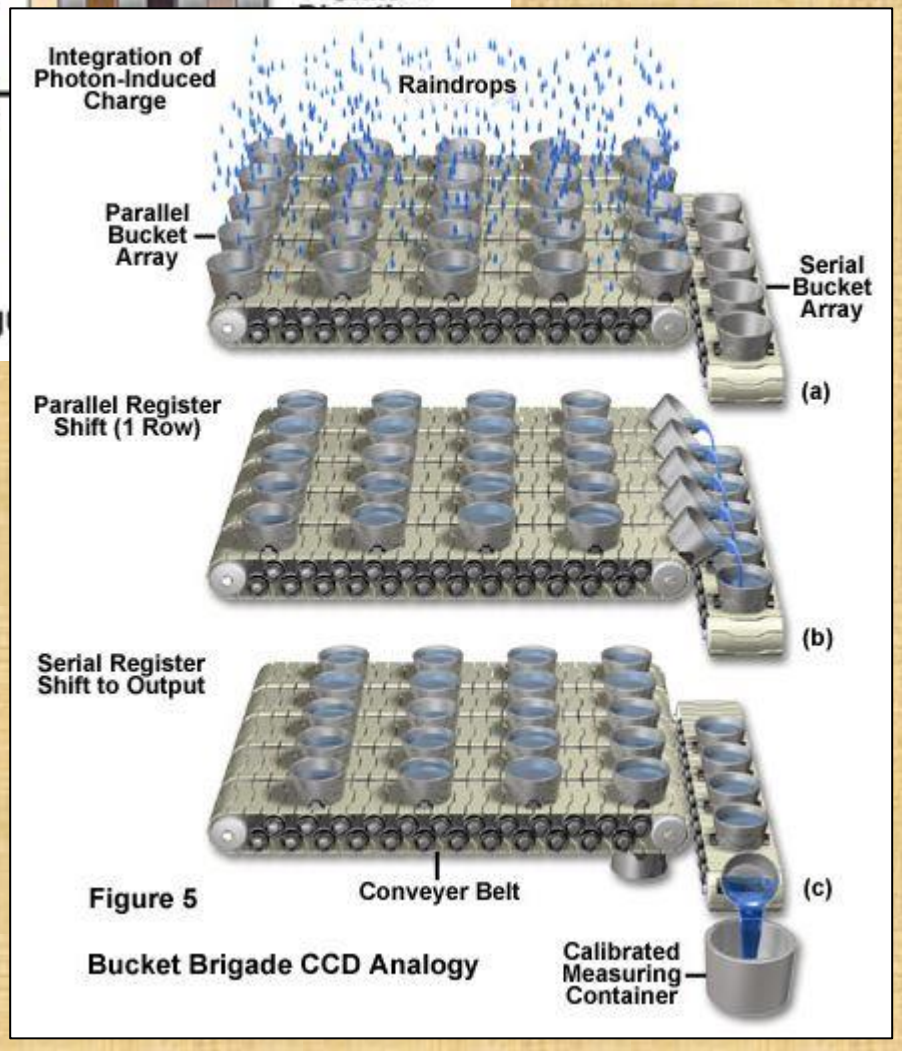
1 pixel





Typical architecture of CCD Detectors



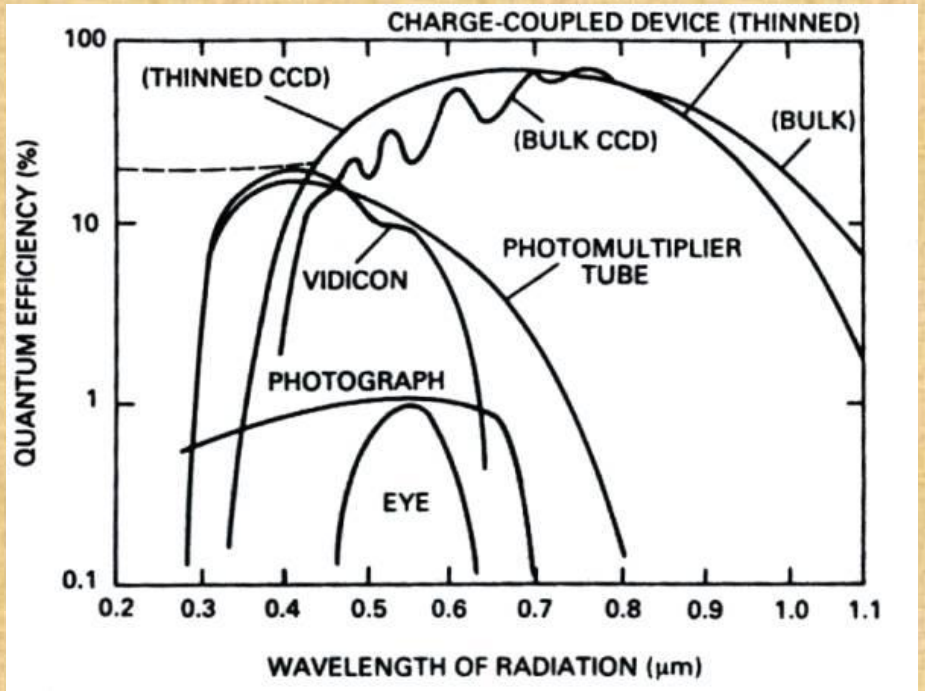


Main characteristics of a CCD

Quantum Efficiency: Ratio of incident energy to detected energy (as measurable charge).

Typical peak values:

Eye:	1-2 %
Photographic plate:	1-2 %
CCDs :	70-90 %
Near-IR det. :	30-50 %



Pixel Size: The smaller the better (microns).

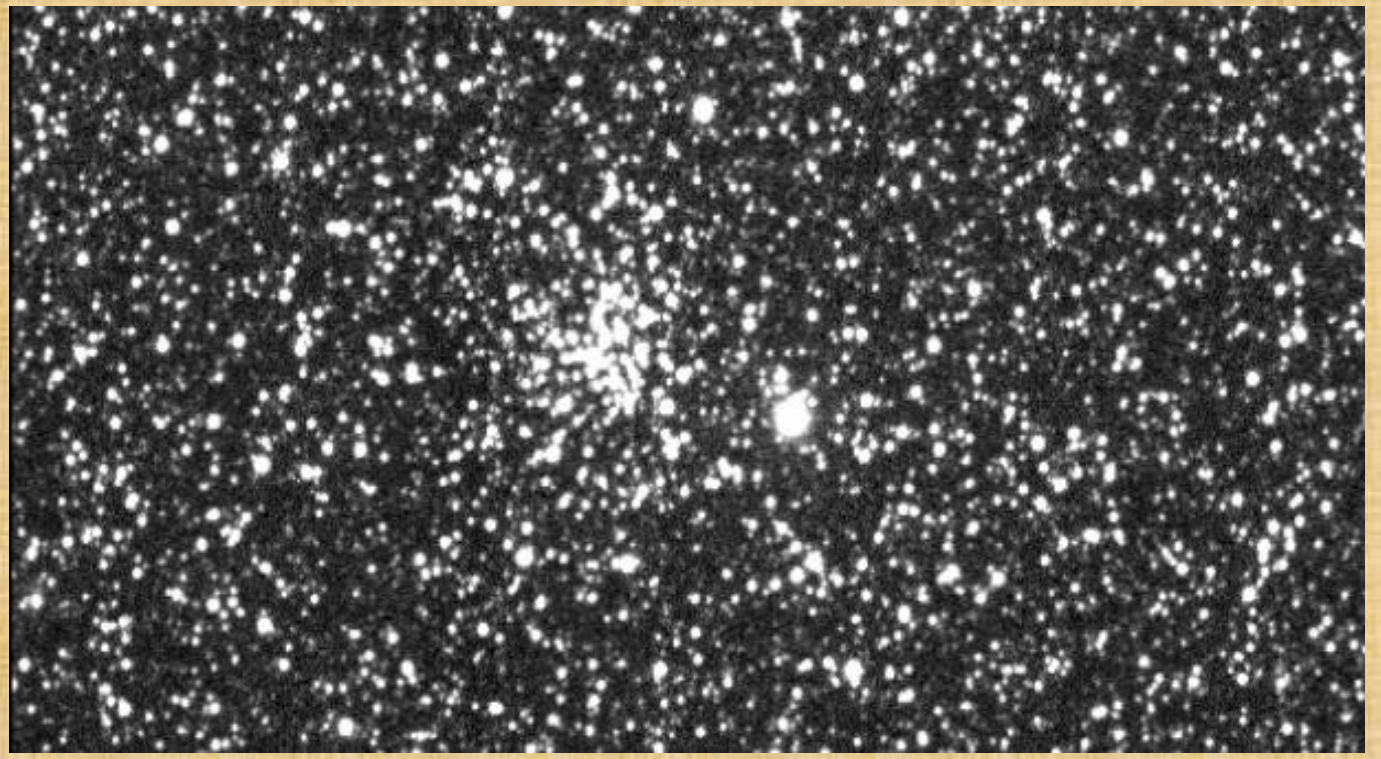
Spectral range: Range over which Q.E. is high enough for reasonable operation.

Readout Noise (RON): noise introduced by the electronics while reading each pixels (in electrons)

Gain: Conversion factor between incident photons and recorded Analog to Digital Units (ADUs). Given in electrons/ADU

Dynamic range/saturation: ratio of maximum to minimum detectable signal *within linear range* (given at times approximately as ADU of saturation)

Imagen astronómica CCD “cruda”



Eventualmente obtenemos una imagen digital que podemos desplegar en un computador. Pero esa imagen NO es la que ingresó por la pupila del telescopio. Está contaminada con señales espurias, impresas por la óptica del telescopio y la electrónica del CCD (el ejemplo es una de las que usarán en la Tarea 4).

Fin de ppt de Clase 11