Observation exam #2 03/10/2008

1- What kind of analysis (explain) can be done on the flux received from an object (5 types)?

2- What are the three measurements used to characterize the seeing (explain: a graphic would help)? Based on your explanation, discuss the quality of the sites listed below: units are $[e_0] =$ arsec, $[q_0] =$ arsec, $[t_0] =$ millisecond. Assuming q_0 was measured at 8 km above ground, compare r_0 at dome C and SPM.

Table 1 **Comparison of observatory site conditions**

Site	ϵ_0	θ_0	τ_0
Dome C	0.27	5.7	7.9
South Pole	1.8	3.2	1.6
Mauna Kea	0.5–0.7	1.9	2.7
San Pedro Martir	0.59	1.6	6.5
Cerro Paranal	0.80	2.6	3.3
La Palma	0.76	1.3	6.6

3- What is a fast telescope? What are the advantages (disadvantages) of a Nasmyth focus over a Cassegrain focus?

4- According to Nyquist's theorem, the optimal f-ratio is independent of the diameter of the telescope. Following this rule, we obtain the table below for optimal f-ratio. What does this implies for the telescope in La Luz: 57 cm diameter telescope used at f/7.5 or f/13.5 with CCD having 9 µm pixels? What is the effect of the bad seeing (2 arcsec) in La Luz on this?

Table 4.5. Typical f-ratios for critically sampled detectors

Wavelength (µm)	0.5	2	2	10
Pixel size (µm)	7	18	28	28
Optimal f-ratio	28	18	28	5.6

5- Photometry terms: explain what is?
   a. Pogson's scale
   b. Multiplexing
   c. Differential vs. absolute photometry
   d. Standard photometric system
   e. Wide band vs. intermediate and narrow band filters
   f. Strömgren system

6- Using graphics, illustrate and explain what are these quantitative features of a spectrum:
   g. Core – flank or edges - wings
   h. FWHM
   i. EW
   j. Continuum
   k. Line intensity – relative intensity – saturated
   l. Spectral resolution

7- The grating relation for a spectrograph is $\sin i + \sin i' = m\frac{l}{a}$. What is the expression of the angular dispersion? Knowing that the angular width of diffraction pattern which form at the pupil is $(di')_{pupil} = \frac{l}{Na\cos i'}$, deduce the expression for the resolution and explain what it means. What would be typical values for an échelle spectrograph? Explain the effect of increasing the width aperture on resolution knowing that the beam etendue is given by the expression: $U = b\,A\,\cos i\,di = Q\frac{A}{R}$, where A = area of grating, and b = the angular height of the slit.

8- In the 80's observational Astronomy was revolutionized by the use of CCDs. Discuss the advantages of CCDs compared to other detectors used at the time (photographic plates and photomultiplier tubes). Explain the working principles of a 3-phase CCD and discuss the advantages of using a backside illuminated CCD.

9- Specific detector characteristics: What is?
   m. Dark current
   n. Cross-Talk or blooding
   o. Dynamic range
   p. Full Well Capacity
   q. Read Out Noise
   r. ADU and relation with Gain

10- The general expression for the S/N ratio is:

$$S/N = \frac{St}{\sqrt{\left(S + Bn_{pix} + I_d n_{pix}\right)t + R_n^2 n_{pix} + \mathrm{var}(B_t n_{pix} t)}}$$

s. Find the expression for source photon noise limited observations. What is the consequence for the exposure time knowing that $S \propto D^2$? What kind of observations are we considering here?

t. What is the expression for Background limited (or sky limited) observations?

u. What is the consequence if the background term is given by $B \approx f_{bkgd} s^2 A$ where f_{bkgd} is the background flux per arcsecond square s is the angular diameter on the sky of the image (seeing) of the source and A is the area of the telescope (in terms of the diameter D)?

v. What is the consequence for a diffraction limited (or spatial) telescope, knowing then that $s = l/D$?

11- BONUS EXTRA POINTS: Based on the diagram below, explain the principle of Adaptative Optic (AdO). What are the limits of such technique?