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1.

a) On April 20th from 22 to 04 o'clock, you have an observing shift in Metsähovi ( $60^{\circ}13'05''$  N,  $24^{\circ}23'38''$  E) to make some quasar flux density observations.

You would like to include two of the "pet quasars" from this course in your observations (Table 1). Can you reasonably observe them during this shift?

(When answering, write down your assumptions/justifications that lead to your conclusion). **(4 p)**

**TABLE 1:**

Source, alias	RA, J2000	Dec, J2000
3C120 = B0430+053	04h 33min 11.09s	+05° 21' 15.62"
Mark421 = B1101+384	11h 04min 27.31s	+38° 12' 31.80"

b) You would like to write an observing proposal to the Atacama Compact Array (ACA) in Chile ( $23^{\circ}01'09''$ S  $67^{\circ}45'12''$ W) to observe these same sources (Table 1).

The ACA Technical Handbook states that observing sources that do not rise above  $30^{\circ}$  elevation should be avoided due to a "shadowing effect", where foreground array elements can block the signal received by background antennas, compromising the sensitivity and imaging quality.

Taking this into account, can you include any of these sources in your proposal? **(2 p)**

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2.

a) In the morning after your observing shift in Metsähovi, Aalto University's management delegation comes to visit the radio observatory, and they ask you to explain what a quasar is. Write here the main points that you want to tell them! Use "your" quasar (or some other "pet quasar") as an example, if you wish! **(3 p)**

b) Explain three different methods (of your choice) to search for life in the universe. **(3p)**

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3.

a) Some radio observatories, like Metsähovi, have their telescopes enclosed within a radome. What are the advantages and disadvantages of a radome? (2 p)

b) Why are hydrogen masers needed in radio astronomy, and especially in Very Long Baseline Interferometry (VLBI) observations? (2 p)

c) You are designing a wide-band receiver for radio astronomical observations. What kind of considerations do you need to take into account regarding Radio Frequency Interference (RFI)? (2 p)

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4. Which one(s) of the statement(s) below are correct?

*Give a one-sentence explanation for your choices to earn 1p per question! (6 p)*

A. When aurorae (Northern Lights) are related to solar flares, we typically observe aurorae ca. ten minutes after the peak of the radio flare.

B. If the brightness temperature of a quasar is ca.  $10^{12}$  K, the physical temperature of the emission region in that quasar can be considerably less than  $10^{12}$  K.

C. "Space weather" means making weather forecasts for habitable exoplanets.

D. At Winter Solstice the highest elevation of the Sun in Metsähovi is ca. 53 degrees.

E. The active regions that we observe on the Sun at radio wavelengths are located at higher layers of the Sun than the optical sunspots.

F. Microquasars are just like ordinary quasars, but they only emit at microwave bands.

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