# Collage 2021 : Final Test

April 29, 2021

**If you want to get extra points from this test, you should submit it by Tuesday 05/04. As agreed this test is for extra credit. So if you already have enough points from homework, you can do this test just as a simple exercise!**

**Question 1:** Which of these two statements better describes line formation in solar atmosphere? Briefly explain.

- Spectral lines are a consequence of absorption, so more absorption there is, stronger the line.
- Spectral lines are solution of radiative transfer equation, their strength is determined both by the amount of absorption as well as the run of the source function with depth.

**Question 2:** How are emission lines formed? (Select all the correct an-

swers).

1. Medium is optically thin.
2. Medium is optically thin, and boundary condition is zero.
3. Medium is optically thick but source function is increasing toward the observer (decreasing with optical depth).
4. Medium is optically thick but absorption can be neglected.

**Question 3:** Why are spectral lines not delta functions? (Select all the correct answers)

1. They actually are delta functions.
2. They are broadened because of thermal velocities.
3. They are broadened because our instruments are imperfect.
4. They are broadened because energy levels get perturbed.
5. They are broadened because of radiative transfer effects.
6. They are broadened because Earth's atmosphere oscillates.

**Question 4:** Which of these statements about the source function are correct:

1. Source function is always equal to Planck function.
2. Source function is only equal to Planck function in LTE.
3. Source function is equal to Planck function in LTE, but also outside of LTE, if some specific criteria are met.
4. Source function is never equal to Planck function.

**Question 5:** Consider Eddington approximation: $I_\lambda = S(\tau_\lambda = 1)$. Which of the following statements best describes it:

1. At given wavelength, we "see" optical depth unity at that wavelength, provided that the medium is optically thick.
2. If optical depth of the object is smaller than unity, we basically don't see the object.

3. Optical depth unity is the only one that is relevant for the spectrum formation.

**Question 6:** Related to the above, sentence: "Different wavelengths probe different heights in the solar atmosphere", applies if (select all that apply):

1. It never applies.
2. If medium is optically thick enough so that our contribution function in height is not constant.
3. Different wavelengths have different opacities for given atmosphere.
4. Only applies if Milne-Eddington approximation is true.
5. If temperature is decreasing with height.

**Question 7:** If radiation at a given wavelength comes from very dense medium, then (multiple answers could be correct):

1. Contribution function for that wavelength is very well defined (narrow).
2. That object emits blackbody spectrum.
3. We see radiation at the given wavelength coming from a very narrow layer.
4. All the radiation at the given wavelength will actually be absorbed.

**Question 8:** If energies of both lower and upper level of a spectral line increased by 2eV, the opacity of the line would:

1. Increase
2. Decrease
3. Stay the same

Explain briefly.

**Question 9:** If we somehow magically increased the mass of the atom where spectral line transition occurs, the width of the line would:

1. Increase
2. Decrease
3. Stay the same

Explain briefly.

**Question 10:** Gradient of velocity in the solar atmosphere can be detected from:

1. Line width
2. Line intensity
3. Line asymmetry
4. None of the above

Explain briefly.

**Question 11:** Imagine observing two completely identical spectral lines with different Lande factors, $g_1 = 1$, $g_2 = 2$. In the weak magnetic field regime, what would be the ratio between Stokes $V$ amplitudes for these two lines:

1. 1:1
2. 1:2
3. 2:1
4. Other

Explain briefly.

**Question 12:** If we detect very weak circular polarization and no linear polarization in a spectral line, that means:

1. There is weak line-of-sight magnetic field and no transversal magnetic fields.
2. There is weak line-of-sight magnetic field, but we can only set upper limit to the transversal magnetic field.
3. There could be arbitrary large transversal magnetic field.
4. Other

Explain briefly.

**Question 13:** Which of these best describes level populations in NLTE regime:

1. They are the same as in LTE, except multiplied by a constant.
2. They are generally different from LTE, but still depend only on local conditions.
3. They are generally different from LTE, and depend on conditions in other points in the atmosphere.

Explain briefly.

**Question 14:** Why do we call NLTE lines: "scattering lines"? (Provide a brief explanation.)

**Question 15:** If a spectral line is formed by purely scattering the radiation, how come that the radiation scattered away from line of sight is not compensated by the radiation that is coming from other directions and is scattered toward the observer?

**Question 16:** If a prominence is visible above the limb but it's brightness is very low compared to the solar disk it means:

- The prominence is very cool.
- The prominence optical depth at that wavelength is very low.
- The magnetic field of the prominence is very weak.
- Our telescope needs better Adaptive optics.

Explain briefly.

**Question 17:** Consider an element of plasma (a blob) suspended at some height over the solar surface, that scatters the light. We look at the Stokes $I$, and Stokes $Q/I$. Ignore magnetic field effects. As we increase the height above the Sun, we expect:

- Stokes $I$ and $Q/I$ to decrease.
- Stokes $I$ to increase and $Q/I$ to decrease.
- Stokes $I$ to decrease and $Q/I$ to increase.
- Stokes $I$ and $Q/I$ to increase.

Explain briefly.

**Question 18:** We observe a plasma loop with narrow-band filter at the wavelength of a collision-dominated line. Turns out the loop is very faint. Which of these explanations are possible:

- Loop is much hotter than expected.
- Loop is much cooler than expected.
- Loop is moving with a very high velocity.
- Density of the loop is too low.
- Density of the loop is too high.

Explain briefly.

**Question 19:** Which aspect of this course was most relevant for your research? What do you think will be most useful for you in your scientific work? Do you think there is any aspect of the course that was useful to you beyond solar-physics related concepts?

**Question 20:** If you could magically increase the number of topics by 8 lectures (25 percent, do not worry about removing existing topics), what would you include or cover in more detail? What could we cover more thoroughly to be most helpful to the projects you are working on?