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Astronomy Exercises for the Artist: van Gogh the Observer

Timothy M. Lawlor
Pennsylvania State University—Brandywine, Media, Pennsylvania 19063
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Abstract

We present a set of exercises designed to be used in a survey astronomy course, an introductory astronomy laboratory course, or in secondary education. The exercises use the great works of Vincent van Gogh but could be easily extended to other works of art. We also include a brief description of our current practices, lectures, and group questions as examples of material that should be discussed prior to use of these "AstroArt" exercises.

1. INTRODUCTION AND LEARNING OBJECTIVES

One objective of this work is to help to provide additional motivation and extend interest and appreciation for the study astronomy to non-science students. We aim not only to engage students in learning astronomical content and concepts but also to engage them in the broader endeavor of asking questions, seeking appropriate and verifiable evidence, revising questions when needed and in general learning how to learn regardless of the topic or question.

We use four paintings of van Gogh to formulate questions that require knowledge of basic astronomy concepts. It is generally believed that van Gogh was a keen observer and often painted accurate depictions of scenery including on occasion the moon and the night sky (Whitney 1986; Dye 1985). This idea has indeed found real use in solving historical mysteries in van Gogh's White House at Night (Olson *et al.* 2001), Edward Munch's The Scream (Olson *et al.* 2007), and Ansel Adams's *Autumn Moon* (Olson *et al.* 2005). Earlier, Whitney (1986) and Boime (1984) carefully analyzed the astronomical significance of van Gogh's night sky paintings, including those that we use here. Both of these references serve as excellent guides for comparison to the answers we provide to our exercises. We include those comparisons in this work. Soth (1986) wrote a thorough analysis focused mainly on van Gogh's painting *the Starry Night*. This work provides some astronomical investigation, though focuses more on van Gogh's motivation and religious influences on the composition. We also refer to the on-line van Gogh Letters Project (http://vangoghletters.org/vg/letters.html, referenced henceforth as "Letters Project"). Our exercises based on van Gogh's paintings are intended to explore the phases of the Moon including time of day and direction of observations, constellation identification, and the daily and yearly motion of the sky. They require and promote active learning and research through the use of on-line resources and a planetarium program which aid in answering questions, solving problems, and confirming or reexamining answers. They can be done in a lecture setting without online access, but information found on-line would have to be provided as given clues for student groups. Some questions do require computer access for identifying constellations for example, thus may be better suited for a laboratory exercise. The reasoning used in these exercises may negate a hypothesis or expose flaws in astronomical artistic depictions as well.

We leave the choice of teaching technique open to the reader. The author has generally used an adaptation of the well-known "Think, Pair, Share" teaching technique (see for example; Slater *et al.* 2003; Forestell *et al.* 2008; Prather and Brissenden 2008) or Problem Based Learning (Shipman and Duch 2001; http://www.udel.edu/inst/).

They can also be adapted for younger learners using, for example, “Claims, Evidence, Reasoning” as described by McNeil and Kragcik (2012).

In Section 2, we review the groundwork of topics and concepts that should have already been discussed before attempting these “AstroArt” exercises. In Section 3, we present the exercises themselves including sample questions and answers, and we compare our answers to previous published studies of paintings. We intend to maintain a database of astronomical facts for any painting and we discuss this briefly in Section 4. Finally, we provide a brief summary and discussion in Section 5.

2. THE GROUNDWORK

In this section, we briefly describe examples of mini-lectures and group questions that should be completed before the Astroart exercises are attempted. The broad topics covered here are the yearly motion of the sky, the motion of the Sun, the phases of the Moon, and the stars and constellations. The yearly motion of the sky is introduced in a usual way, with a diagram of the Earth and Sun from outside the system. Particularly, we are careful to distinguish the night and day sides of the Earth, and couple this with concepts relating to Earth’s orbit, rotation, the ecliptic, the zodiac and circumpolar constellations. Once students understand why we see different constellations during different seasons, we break into groups to discuss why it is that Ursa Major, for example, can be found in the night sky all year long from our geographic location in the northern hemisphere. These preliminary exercises are useful for a variety of reasons. For one, they introduce the concept of observation relative to location on Earth and relative to time of day on Earth. This leads naturally into discussion of reason for the seasons and a similar model of the system is used for discussing the phases of the Moon.

Here, we present two sample questions that pairs or small groups of students discuss during lecture class, typically using an impromptu version of “Think, Pair, Share.” For example, the instructor lists three or four different answers on the board, and students are asked to vote by holding one, two, three or four fingers up in below their chin to vote on their answer. This allows the instructor to decide in real time if the topic needs more time for discussion and makes it difficult for students to see each other’s answers, eliminating the discomfort of giving the wrong answer. Some sample questions related to the yearly changing night sky are as follows:

A close friend asks you to proof read a poem that he wrote for a creative writing class. The poem meanders on and on about a walk along the beach and makes note of how the constellation Orion seems to follow him along the coast no matter what time of year it is. You are forced to correct your friend— how and why?

Unfortunately in the same poem, your friend describes in great detail watching the Little Dipper set over the ocean down on the Jersey Shore. What are the problems here?

The yearly motion of the sky also gives rise to the reason for the seasons and why and where we can experience 24 h of light or darkness. An example of diagrams used in mini-lectures to discuss this topic is shown in Figure 1.

Before beginning to study the reason for the phases of the Moon, we lead with group questions based on Figure 2, which is designed to further cement the concept of observational perspective. It cannot be overstated how

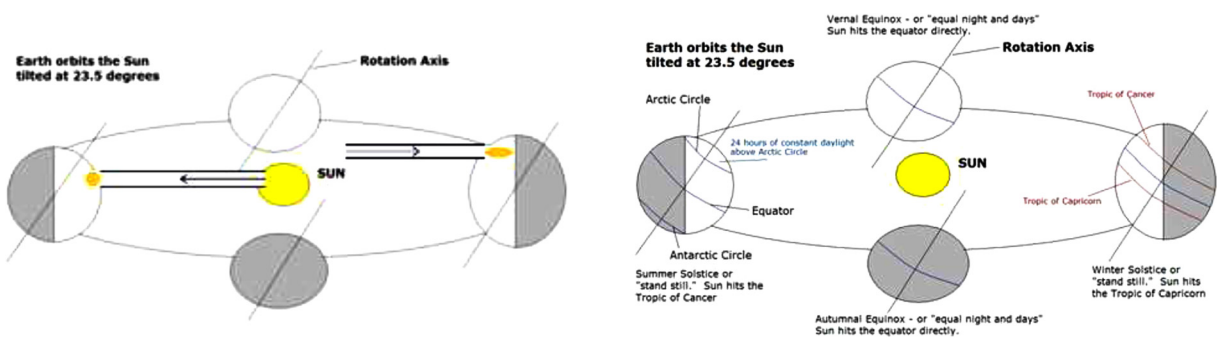
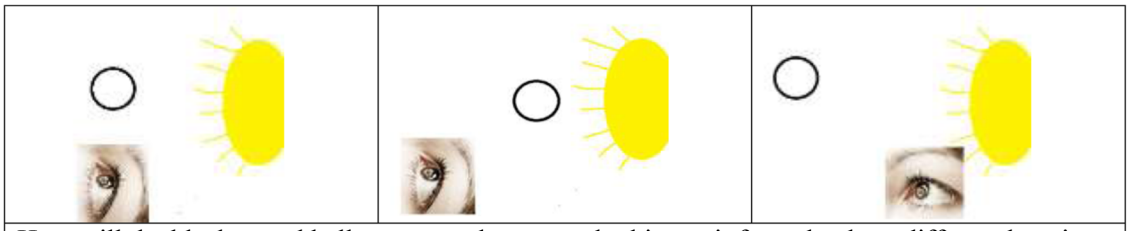


Figure 1. Sample diagrams for discussing the reason for the seasons, and other implications. Obviously this is not drawn to scale. The size of Earth is exaggerated to make it more clear what causes the seasons and to point out the tropics and circles. This model introduces the terminator between night and day, which introduces an important concept in discussing the phases of moon later



How will the black round ball appear to the person looking at it from the three different locations shown? Sketch how it will look in each case.

Figure 2. Putting observing into perspective and perspective into observing

difficult this tends to be for students to grasp. Even given these simple diagrams, it is often difficult for some students to predict what the ball will look like from the observer's position. This uncovers a fundamental issue in trying to teach the reason we see phases of the Moon, which is a more complicated situation than this example. In the ideal case of being in a laboratory course, or having a small lecture class (which is probably uncommon), this exercise can be carried out with a bright lamp or overhead projector and a ball. We have found that racquetballs show the terminator better than other choices.

Finally, in Figure 3, we show an example of the model that we use for discussion the phases of the Moon. Note that in this model, we remove the tilt of the Earth relative to the ecliptic, ignore the inclination of the Moon's orbit, and approximate the orbital period of the Moon. From this diagram, one can extract three pieces of information: Lunar phase, approximate direction of observation, and approximate time of day of observation. Given any two of these, the third can be uniquely determined. The corresponding mini-lecture that goes along with this slide consists of eight of these diagrams, with each phase being discussed one by one. Again, this is only a brief summary. We use many other resources, such as applets, pictures, and descriptions, when approaching this difficult to teach topic.

Next, we present three lunar phase related questions used for group discussion:

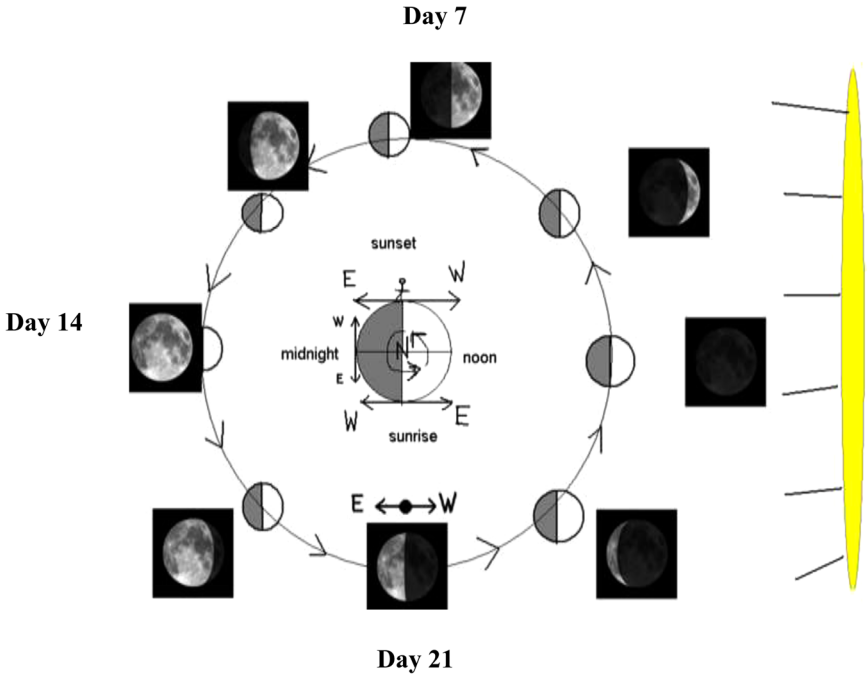


Figure 3. Sample model for discussing the phases of the Moon. An interesting discussion point is to explain why the portion of the visible moon points *away* from the Sun for the waning phase pictures. Two other difficulties arise from this model. One is that "south," as defined for an observer in the northern hemisphere, is not the same as for our observer shown on the equator. A moon high in the southern sky for a northern observer would instead be best described as directly overhead by an observer on the equator. Second, the 2-D depiction sometimes creates confusion in understanding what one can or cannot see when looking toward north from the position on the equator. For example, when asked what direction one should look to see the last quarter moon at *sunset* (which is a trick question) students occasionally answer "north," as if the Earth is a flat disk that can be looked through

Out for a walk one evening, you have become a bit turned around. You were supposed to head west on Broad Street and cannot recall which way is west! It is the early evening and the Sun has already set. Scrambling for a clue, you look up in the sky and see a thin crescent moon close to the horizon. How can you use all of this information to walk in the right direction?

If your friend tells you that they have seen a full moon in the western sky, what time of day can you conclude that they were viewing the Moon?

In what direction will you see the Moon if it is in the waxing crescent phase at sunset?

By this time during the semester, students would also have been exposed to basic constellation recognition and if in a lab course, they would have extensive hands on use with a planetarium program such as STARRY NIGHT BACKYARD or STELLARIUM. Lecture students will be at least visually familiar with this software. Such software is an important tool for some of the questions presented in the following section. Topics explored during lecture using planetarium software include the daily motion of the sky, circumpolar constellations, zodiac constellations, *inaccurate* astrological signs, and yearly motion of the night and daytime skies. We note that STELLARIUM is an open source software (i.e., free to download).

3. ASTROART EXERCISES WITH SAMPLE QUESTIONS AND ANSWERS

A number of van Gogh's paintings depict scenes that include observations of the night sky. During the spring and summer of 1888, the artist became preoccupied with painting a starry sky. In a letter dated on April 19 to Emile Bernard (Letters Project), van Gogh wrote "A starry sky for instance—look that is something I should like to try to do." On June 18 of the same year, he writes again to Bernard: "But when shall I paint my starry sky, that picture which preoccupies me continuously?" He did get around to painting two starry night scenes in September 1888 and the iconic *Starry Night* in June 1889. He included the Moon in other various paintings as well. In some of van Gogh's night sky paintings, stars and objects are immediately recognizable, but we can find out more form his observations. Though we only include van Gogh in this set of exercises, there are likely many more artists to be used across a variety of mediums. Here, we present four of van Gogh's well known paintings and of course we begin with *the Starry Night*.

3.1. The Starry Night—St. Remy-de-Provencal, France, June 1889

Sample questions:

What is the phase of the Moon that Vincent van Gogh depicts in this painting?

The phase shown is a waning crescent phase (more on this below) (Figure 4).

Figure 4. The Starry Night

What time of day would you predict van Gogh observed this scene? What evidence can you cite to support your claim?

The time of day depicted is early morning. The primary evidence is that the left side of the moon is illuminated and the moon is close to the horizon. Another way to determine this is by using the Earth-Moon-Sun diagram shown in Figure 3.

Approximately what direction was van Gogh facing when he painted this scene?

Van Gogh was looking toward the east. Because the waning moon is rising, it has to be in the east direction (also see Figure 3). The illuminated part of the crescent moon always "points" toward the Sun. In this case it is the rising Sun, which rises in the east.

If a planetarium program is available, and after searching online to find approximately when and where van Gogh painted this scene, determine as best you can the date and range of time of day that van Gogh may have observed this scene. Do not forget that you must set the correct geographic location in the software. Record all references for collected data. Using the planetarium software, what constellations and other objects can you identify in this painting?

From a rudimentary on-line search, one can find that van Gogh observed this scene in June 1889 in Saint-Rémy-de-Provence, France. Deciding an exact time and date and identifying stars is problematic because we cannot tell the exact scale that van Gogh used. In fact, the Alpilles foothills shown in the painting are known to be exaggerated in steepness of slope (Soth 1986). But based on the time of day and the location of the waning crescent moon relative to the horizon, it is possible to identify Venus to the right of the foreground Cypress tree. Whitney (1986) also identifies the phase as crescent in the easterly direction and suggests from van Gogh's letters that Venus was observed in May. If we estimate by the orientation of the Moon and Venus, we can find a range of time of day using a planetarium program. Based only on this celestial orientation, a good guess is on June 21, 1889 between 3:45 am and 4:10 am. We note here, however, that although this is visually a very good match, it has been proven (Whitney 1986; Soth 1986 and references therein) that van Gogh completed the Starry Night before on June 18, 1889. This is based on van Gogh's own words referencing the painting in a letter to his brother Theo (Letters Project) dated on or about June 18: "At last I have a landscape with olive trees, and also a new study of a starry sky." Both Whitney and Soth confidently report that the painting was completed between the dates on June 16–18 based on van Gogh's letters. Specifically, they cite that he did not mention it among completed works in a letter to his sister dated on June 16 and then did refer to it in a letter to Theo on June 18 (Letters Project) as quote above. Although this is strong evidence for the exact date being between 16 and 18, it may be possible if not likely that van Gogh simply did not mention it in the letter to his sister. Perhaps, he saved the description of a starry night for his brother? In any case, this date range is generally accepted to be the range for the completion of the painting. Boime (1984) identifies the date as on June 19. Even so, on all of these dates the moon was in the waxing gibbous phase, which is clearly not what is depicted in *the Starry Night*. Boime suggests that perhaps van Gogh changed his mind and artificially changed the gibbous moon to crescent, though there is no real compelling evidence for this.

If we take a leap, and assume that van Gogh painted this scene in June but observed it at the end of May, which is at least implied by Whitney, one may guess that the scene was observed on May 25 around 4:30 am. On that morning, Venus and Aries are a bit closer, but again there is no concrete evidence for this claim. This date does show the complete sky though, including the crescent moon. It may be possible that Soth offers the right interpretation for the discrepancy in phase. Soth writes that van Gogh painted the crescent moon, church and village from a memory of the painting "Fesival of St. John," by Jules Breton. Soth believes that Starry Night in an 'imaginative amalgam' from both memory and local scenery. In any case, for the sake of this exercise, the arrangement of the Moon and Venus may lead students to conclude that on June 21 (or so) is the "right" date, even though it was certainly painted before June 18.

It is difficult in this painting to identify exact stars or constellations, but one could well argue that the stars above Venus and the tree belong to the constellation Aries, while the stars just to the left of the Moon may belong to the constellation Pisces. The identification of Aries is in agreement with the work of Boime (1984). In contrast to Boime, Whitney does not believe that the constellations can be identified and goes on to suggest that an entirely different part of the sky, including the glow of the Milky Way and the constellation Cygnus, have been transposed onto the scene. Given Soth's convincing discussion about van Gogh's shift to using imagination to depict nature and make it better than reality, it is possible he moved the sky.

3.2. Road with Cypress and Star—April–May 1890

Sample questions:

What phase of the Moon is shown in this painting?

The phase of the Moon shown is a waxing crescent. The right side of the moon is illuminated indicating that it is waxing. This is confirmed by Whitney (1986) who reports that the scene was two to four evenings after new moon. Whitney also notes that the tilt of the moon is slightly off in that it is parallel with the horizon which would indicate the Sun had not yet set (Figure 5). Van Gogh himself offers an interesting topic for discussion about a common misconception about the reason for the phases of the moon. In a letter dated on June 17, 1890 to Paul Gauguin (Letters Project), van Gogh writes:

"A last try—a night sky with a moon without brightness, the slender crescent barely emerging from the opaque projected shadow of the earth—a star with exaggerated brightness, if you like, a soft brightness of pink and green in the ultramarine sky where clouds run."

Seemingly van Gogh is suggesting that the shape of the crescent moon is caused by the shadow of Earth, thus confusing it with a lunar eclipse. This very common misconception persists today.

Approximately what time of day does this scene depict and what evidence do you have for your claim?

This scene is during the evening, shortly after sunset. The telltale signs of this are that the Moon is in the waxing crescent phase and is fairly close to the horizon. These two observations allow one to use Figure 3 to predict the time of day. Also, the illuminated portion of the crescent moon is "pointing" toward the setting Sun, thus it is after sunset.

In what direction was van Gogh facing to paint this scene?

Because the illuminated portion of the crescent moon "points" toward the setting sun, we can conclude that van Gogh was (roughly) facing west. This is again supported by Whitney (1986) who determines van Gogh was facing southwest.

Figure 5. Road with Cypress and Star

If a planetarium program is available, and after searching online to find approximately when van Gogh painted this scene, determine as best you can the date and range of time that van Gogh may have observed this scene. Can you identify the bright object to the left of the cypress tree? Do not forget that you must set the correct geographic location in the software.

We can find from on-line resources that this painting was done during May 1890, about three months before the artist's untimely death (see, for example: http://www.vangoghgallery.com/misc/chrono.html). It can also be found that this was done in the evening, which is clear from the lunar phase, but also from letter RM23 in the van Gogh Letter Project (http://vangoghletters.org/vg/letters/RM23/letter.html). Here again scale is tricky, and thus the exact time in the evening is also approximate. A possible identification for the star, time of day, and date include: April 22–23 between 8:00 pm and 8:45 pm: If this is the case the star to the left of the waxing crescent moon could be the armpit of Orion the Hunter, Betelgeuse. This is consistent with the analysis of Whitney (1986), who makes this same suggestion. The star could be Sirius if the scale is greatly exaggerated and Betelgeuse is behind the foreground tree. Whitney (1986) concludes that the painting was completed between May 13 and 16 but observed between April 21 and 23. This conclusion is made because April 19 would have been the last New Moon that occurred, while van Gogh was still in St. Remy, before he left. Whitney goes further to settle on April 21 based on meteorological records, which would make the crescent moon only two days old. The orientation of the Moon and star (assuming we settle on Betelgeuse) on April 21 is not as close to the orientation in the painting as is on April 22, but it is hard to argue with meteorological records. The orientation on the 21 is fairly good for the star Rigel which is also the quite bright, and the bright star Aldebaran is also nearby. The orientation for Aldebaran is also not quite right.

Based on the "right" orientation only, a student may choose on May 22 between 8:15 pm and 9:00 pm: In this case, they may predict that the star is Procyon, whose apparent magnitude is approximately +0.04. One might argue that it is a bit later than 9:00 pm because earlier than that, Venus would be quite visible. However, this date in reality is ruled out (see for example, Hulsker 1990). Further evidence for ruling it out arises from letter 873 from van Gogh to his brother Theo (Letter Project) dated on May 20. Van Gogh wrote this letter from Auvers-sur-Oise. Thus, van Gogh had already been discharged from the hospital of St. Paul-de-Mauole and had left St. Remy where this painting was composed before on May 22.

Finally, it may be suggested that the "stars" in this scene are Venus and Mercury which appeared in the sky on April 21, 1890 until at least 8 pm, but for this to be the case both planets would have had to have been switched to a mirror image, vertically about the Moon. Both appeared to the right, not the left, of the moon on that evening. This would be an interesting claim for a student to make, however, Mercury is usually quite dim and this was just after sunset, making it a dubious claim in the opinion of the author.

3.3. Café Terrace at Night—Arles, France, September 1888

Sample questions:

If a planetarium program is available, and after searching online to find approximately when van Gogh painted this scene, can you identify the stars or constellation in this painting?

In what direction was van Gogh facing? Do not forget that you must set the correct location in the software. Record all references for collected data. During what time of year was this scene painted? What evidence do you have to support your claim?

One can find that this painting was painted in Arles, France (letter 678, Letter Project, for example). In fact, the café still exists and has been refurbished to look the same as it did in van Gogh's painting. Given this landmark's known location, we can find that van Gogh faced south. One way to do this is to use Google Maps street view to virtually visit the café. Unfortunately, you can only view it from about a block away, as Google does not image this specific street. But between the view from a block away and current day pictures it is possible to tell that the café is on the east side of the street. The direction is also confirmed in Boime (1984). From van Gogh's perspective, on the left or east side of the street, his view appears to be slightly southwest (Figure 6).

As a disclaimer, the author admits that he has always thought that the constellation depicted here looks like the constellation Scorpio, with Antares being the star on the top left and the stars on the right completing Scorpio's

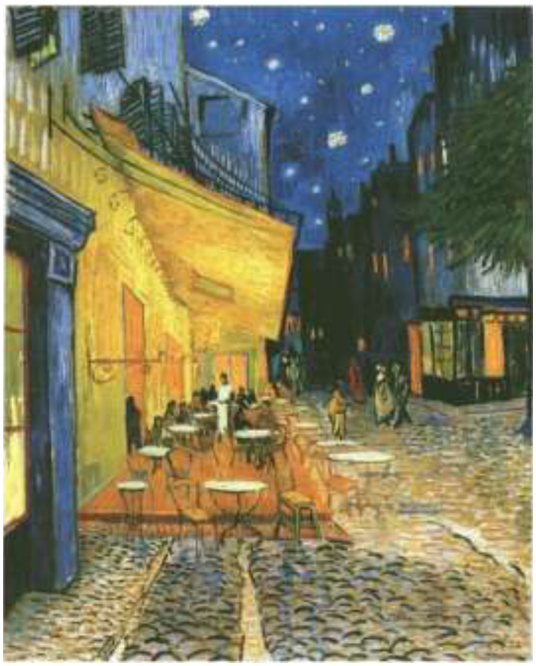


Figure 6. Café Terrace at Night

familiar "V" shape. The stinger would extend out of site behind the buildings on the left. In a letter to his sister, van Gogh describes how he was interrupted in writing his letter to her by painting this scene. That letter was written beginning on September 9 and continued on September 16, 1888. During this time in the evening, the constellation Scorpio does appear just west of south. Interestingly, at that same time, the very bright planet Jupiter was situated just to the right of the constellation. And further, Mars moved directly through this constellation during those dates. For Scorpio to be the right guess, the observation of the sky would have had to have happened during civil twilight, around 7:15 pm. It could be that the sky was observed or painted earliest before the street scene, and the sky view would have of course changed by the time the painting was complete. If this is the case, we can rule out on September 11, since the moon would have been dominating the constellation on that evening. Although the claim is unfounded, it is worth noting that the space between the buildings is rather narrow and so the stars would have almost certainly changed over the course of the completion of the painting, so the observation of the stars and sky may not be from the same time as the café in the foreground. If the two brighter 'stars' on the right side of the painted sky are Jupiter and Mars, it could explain why these are a bit brighter than the quite bright star Antares. In fact between September 11 and 13, Jupiter and Mars were very nearly on top of the right side of the "V" of the constellation. If this is not the definitive answer, it is worth considering that these bright objects may have been the inspiration for the scene. Considering this answer, some possible dates and times for the sky are then:

September 10 between 7:15 pm and 8:30 pm, or slightly later on September 12–16. The later dates allow for a darker scene, but Scorpio moves further southwest making it less likely, unless the sky was observed earlier. In this composition, Whitney (1986) does not believe that the stars can be convincingly identified and that they have no real basis in the sky. On the other hand, Boime (1984) seems convinced that the scene was observed around 11 pm, based on the lack of café customers, and that the stars are part of the constellation Aquarius. The author finds this an unlikely answer primarily because the brightest stars in Aquarius have an apparent magnitude between about 3.0 and 4.0 and so are not particularly bright. This would especially be a problem close to the café lights.

Another possibility is that the scene was later in the evening (8:00 pm to 9:00 pm) and these stars belong to the "tea pot" stars in the constellation Sagittarius. This would rule out on September 13 and 14 because the moon would have dominated that part of the sky and would have been quite bright, in a later phase. The positions of the stars are similar (with some imagination) as the spout and top of the lid of the teapot, thought the relative brightness of the stars is wrong. Here again, none of the stars are all that bright, with magnitudes between about 1.8 and 3.0. The brightest star in the painting would be the one with the highest magnitude (or the least bright).

3.4. Starry Night over the Rhone—Arles, France, September 1888

Sample questions:

Can you identify which constellation is shown in this night sky scene?

Immediately identifiable, this is the constellation Ursa Major. It contains the most easily identifiable asterism, The Big Dipper.

What direction would you predict that van Gogh was facing while viewing this scene? What evidence can you cite to support your claim?

Astronomically, one may predict that van Gogh was facing north. The evidence for this is that the front two stars of the dipper are used as pointers to the North Star, Polaris. In this case, they point straight up. Note here that it has been shown in numerous places that van Gogh was actually facing southwest and transposed the northern constellation onto the sky artificially. One can witness this fact directly using Google Maps street view to view the relatively recognizable scene, including the Trinquetaille bridge, by virtually standing on the street Chemin des Segomaux just south of Place Lamartine in Arles, France. On this street, one must face southwest in order to see the scene (Figure 7).

Although not specifically included in these exercises, Whitney (1986) performs an excellent exercise that would be well suited for a lecture or lab at this level. By using the Big Dipper, he approximates the scale of angle on the sky. Using his approximation, he estimates that the bowl of the Big Dipper is about 11° from the horizon, and knowing that the North Star is 33° above the bowl he finds that Polaris is about 44° above the horizon—an angle very nearly the same as the latitude of Arles, France. This demonstrates the usefulness of estimating angles in the sky, a typical Astro 001 topic, as well as it demonstrates that Polaris is an angular height above the horizon that is roughly equal to an observer's latitude. It is also a testament to the carefulness with which van Gogh painted the stars over the Rhone.

If a planetarium program is available, and after searching online to find approximately on what date van Gogh painted this scene, can you confirm your choice of constellation and direction? If so, approximately what time of day did van Gogh observe this constellation? Describe all evidence and reasoning that lead you to your conclusions.

Ignoring the true direction of the scene, we can still guess at what time of day van Gogh would have had observed the constellation by observing its orientation in the sky (upright and on the horizon). Van Gogh really did view the Big Dipper, as is indicated in letter 691 (Letters Project), in which he refers to Ursa Major, the Great Bear:

"Against the green-blue field of the sky the Great Bear has a green and pink sparkle whose discreet paleness contrasts with the harsh gold of the gaslight."

Figure 7. Starry Night over the Rhone

Here, his description of a “green and pink sparkle” is likely due to atmospheric diffraction and confirm the stars’ location low on the horizon.

One can find that this painting was also done in Arles France during the same month as the Café Terrace at Night, September. In the same letter to his sister, van Gogh mentions that “At present I absolutely want to paint a starry night.” Since the Café Terrace at Night was done between the 12 and 16, we conclude that this was observed sometime after the 16. By primarily using the orientation of the Big Dipper in van Gogh’s sky, we estimate two dates over a range:

On September 20, the constellation would have been viewed in this orientation between 10:30 pm and 11:15 pm. If the observation were later, say on September 27, the time of night would have been a bit earlier between 10:00 pm and 10:45 pm. This is in line with the finding of Whitney (1986). Boime compares the painting to the sky at 9:00 pm and suggests that this indicates that van Gogh tilted the constellation upward. It is not immediately clear why he suggests this, but 9:00 pm does not compare well to the painting.

4. FUTURE DATABASE

One additional motivation for these exercises is to create and maintain a database for collected information about well known, or even less known, works of art in any medium that includes any accurate astronomical scene. It will also be possible to keep track of semi-accurate examples, as well as indicate those that are not real depictions. In this regard, student work can be used to fine tune the details of the observations. The database will include items such as identifiable objects and constellations, time of day, possible dates, direction of observation, and lunar phase if applicable.

5. SUMMARY AND DISCUSSION

We have presented a sample of astronomy exercises that take advantage of the careful and keen eye of Vincent van Gogh. They encompass what would typically be the first two or three chapters of a survey college level astronomy course, using concepts such as phases of the moon and how the sky moves daily and annually. For the non-scientist, these topics can be particularly challenging and many common misconceptions continue. For an impressive list of common misconceptions, see as an example, http://www.physics.umaine.edu/ncomins/. When Whitney and Boime undertook their studies of van Gogh’s skies, they utilized connections at a full scale planetarium to recreate the sky scenes. Thanks to easily accessible planetarium software, one can retrace their steps, think critically and draw their own conclusions. We hope that applying concepts of astronomy to the artistic masterpieces of van Gogh will provide additional motivation and interest to non-science students. Indeed the opposite is true that astronomy in art has raised the author’s interest in art. I was lucky enough recently to visit Musée d’Orsay in Paris and view *Starry Night over the Rhone* in person. In person, the composition and colors are absolutely breathtaking. The author finds it remarkable that such deep interest in the philosophy, motivations and thoughts of van Gogh have persisted for more than a century after his premature death. This seems especially so for his paintings of the night sky. It may be that the cyclic nature of the sky provides a familiar pallet and feels like a connection to the past. Certainly, van Gogh has sent his familiar pallets forward to generations and for that the author is very grateful.

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