Our Galaxy and Venus in Setswana as a Tool in (Astro)Physics Education

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Abstract. Excitedly awaiting the Square Kilometre Array (SKA), the world's largest radio telescope, being built primarily in Southern Africa, and the full scientific operations of the Southern African Large Telescope (SALT), and the very faint and distant celestial objects these telescopes will observe, we present an exemplary lesson of our Galaxy and Venus in the Setswana the Setswana language of Southern Africa. This short paper opens the window to the potential benefits of such a lesson as a teaching tool in (astro)physics education, that may be one of the methods useful for spuring an increased number of young Southern Africans to consider a study of the night sky and careers to use these power telescopes at their doorsteps. The presentation showcases an example for broadening access and understanding of astrophysical concepts and exposing a relatively unpublicized astronomical interest of the Batswana people, and local Southern African people in general.

1. Introduction

For many generations, Africans, like many people across the globe, used their natural astronomical instrument, the human eye, to observe, comment on, and name celestial objects that interested them (cf. Leeuw 2007, 2014). Most of these objects are very bright and relatively nearby to Earth and can thus be seen by eye, without requiring the use sophisticated or expensive tools. On the other hand, most of modern astronomy uses data from large telescopes, and its study can deal with the very faintest and most distant observable objects in the Universe.

The scholarly study of modern astronomy and its teaching in schools and universities is done almost exclusively in English, which is its assumed international and standard language and certainly of most scientific journals. Such an approach is often built on a notion that interest in the subject is primarily Western and that there is no similar interest in the local Southern African cultures. This approach can alienate some local learners or, at least, miss the opportunity to build on what learners may know, particularly those who may already have some home taught knowledge of the night sky from their own cultures.

In anticipation of the world's largest radio telescope, the Square Kilometre Array (SKA), and its smaller predecessor, the MeerKAT, being built primarily in Southern Africa, the full scientific operations of Southern African Large Telescope (SALT), and the very faint and distant celestial objects they telescopes will observe by a large number of scientist that should include an increased number of local ones, this paper presents our Galaxy and Venus in the Setswana language of Southern Africa (SA), as a teaching tool in introductory (astro)physics education. The lesson showcases our Galaxy, the conglomeration of stars of which our Sun is a part, and

Venus, the brightest and nearest astronomical body from Earth after the Sun and Moon. The idea is to explore the potential benefits of this exemplary lesson in (1) broadening access and understanding of scientific concepts by local students and non-specialists and (2) exposing a relatively unpublicized astronomical interest of the Batswana people, or Southern African people in general.

2. Our Galaxy, the Milky Way or Molagodimo

Figure 1 shows a photographic mosaic of our Galaxy, the Milky Way, or *Molagodimo* made by astrophotographer Axel Mellinger between 1997 and 2000. Our Galaxy as seen by the human eye, or an optical camera, is a myriad of patterns, i.e. a multitude of stars among dark patches of dust and gas, that astronomers now understand is forming new stars. Indeed, for the night sky and stars, there is a riddle in the Setswana language of Southern African that says, *mosese ya ga mmakgathi, maranthatha* or "the dress of the painter (a female one) is a myriad patterns." This Setswana riddle demonstrates an old, though refreshing interest in the stars and night sky by the Batswana – a fascination that is deeply woven in the language and culture of the people of Southern Africa, riddled with idiom, poetry, indirect or evasive speech and educational potential. *Mosese*, or literally a dress, is also poetically used to mean a woman, in Setswana. It is coincident that the beautiful patterns of this dress or a woman, is partly made so by stars and cosmic dust, out of which future stars are born. The beauty of the coincidence lies in that *mosese*, or a woman, bears children, and in Setswana culture traditionally cares for them, making a great analogy of the Galaxy, with its stars and dust from which future stars will be born.

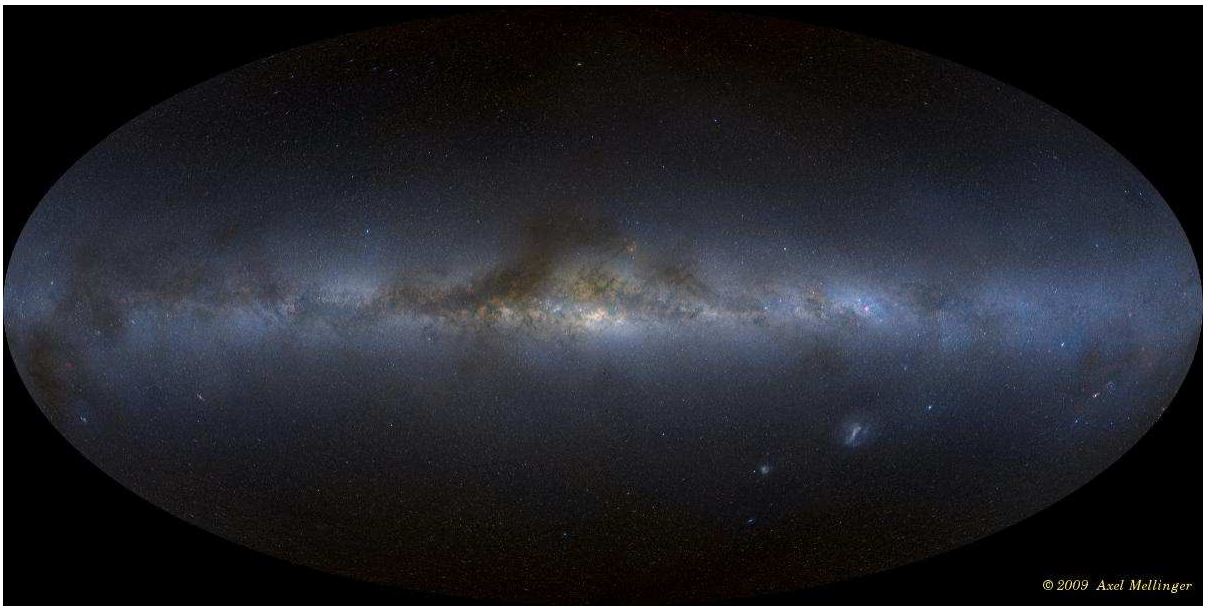

Figure 1. A panoramaic mosaic of the night sky made by Axel Mellinger from dark-sky locations in South Africa, Texas, and Michigan, using the three optical digital photography colours or filters *RGB* (Mellinger 2009). The map, with our Milky Way Galaxy or *Molagodimo* in the centre of the image, is plotted in a Hammer-Aitoff projection, which is an equal-area map of an equatorial form and shows the central disk of the Milky Way with its multitude of stars and dust that will form future stars. As well as stars, dust, and nebulae in our Galaxy, the Milky Way's bright neighbour galaxies Andromeda and Magellanic Clouds are also shown in this map off the central part.

The Setswana name of our Milky Way Galaxy itself or *Molagodimo*, means the path (or

mola) above (or *godimo*). Like the meaning of "way", in the Milky Way, it is called path both in English and Setswana because the Galaxy, as seen from Earth, looks like a path. This is because Earth and our Sun, around which we revolve, sit inside a disk-like part of the Galaxy. This disk is made of a concentration of stars interlaced with dust and is the main stellar component of the Galaxy. In fact, we sit about two-thirds from the centre of this disk-like part of the Galaxy; and, when looking along the direction of this disk from the location of the Earth, the disk or, if you like, the Galaxy itself, looks like a path. Both these simple English and Setswana names of our Galaxy therefore tell about the main disk component of the Galaxy and how it appears from Earth. The projection of the Galaxy as would be seen in the Northern and Southern Hemispheres respectively on the left and right of the picture in Figure 2.

3. Venus, the "Evening or Morning Star"

Venus, the goddess of love and beauty - according to Greek Mythology, is the third brightest celestial object in sky, after the Sun and Moon. In Setswana, Venus is *Kopadilalelo* (or, seeker of evening meals) as seen at sunset or *Mphatlalatsane* (or, the brilliant one) as seen at sunrise. The inner planets, Mercury and Venus, always appear in the West or East with the Sun - never opposite to it. Mercury is dimmer and only visible a few weeks a year, so the brighter Venus, is the one called the "Evening or Morning Star", by the Batswana and many across the globe, depending on when it is sighted in the sky.

Figure 2. A NASA true-colour image of Venus, the "Evening or Morning Star"

Venus does not appear as the "Evening and Morning Stars" on the same day in the sky. In fact, the periods of appearance as evening and morning stars respectively last around nine months, with other smaller periods in between. Viewed through a small telescope (e.g. by Galileo in 1610 when he observed these phases), Venus has phases; and, when it is at its brightest, it is in a phase of a crescent, a few say they have resolved by naked eye or seen make shadows.

The orbital (i.e., period versus stars from outside Earth) and Synoptic (i.e., period versus Sun from moving Earth) periods of Venus are 225 and 584 Earth days. Now, 225×13 is about 8×584 is 5×365. Thus, Venus orbits the Sun 13 times in 8 Earth years, passing Earth 5 times. The synoptic cycle of Venus takes 584 Earth days, about 263 continuously as evening star and then morning one, and 8 and 50d ays in between on the near- and far-side from the sun. Thus the reason Venus was thought of as two separate celestial objects by the Batswana and many across the globe.

Venus is the second-closest planet to the Sun, orbiting it every 224.7 Earth days. Its mean surface temperature is 735 K or 460 °C. Venus has few impact craters, demonstrating that the

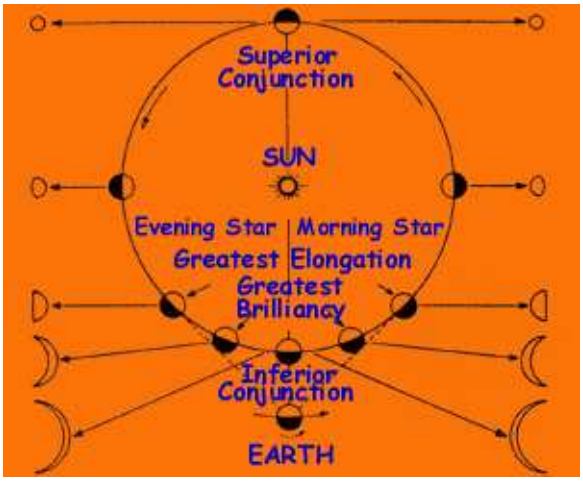

Figure 3. The relative positions of Venus, its apparent size and phases and the Earth are indicated on the diagram, which has been simplified by keeping the Earth's position fixed (http://www.absoluteaxarquia.com/nightsky/venus.html).

surface is relatively young (about 0.5 billion years) and perhaps, how Earth was when young. Classified as a terrestrial planet, it is sometimes called Earth's "sister planet" because they are similar in size, gravity, and bulk composition. Classified as a terrestrial planet, Venus is sometimes called Earth's "sister planet" because they are similar in size, gravity, and bulk composition. Perhaps because of its age and temperature, Venus can be though of as Earth, younger and hotter or more temperamental sister or as the Batswana call it, *Kopadilalelo* (or, young, seeker of evening meals, the bringer of night) as seen at sunset or *Mphatlalatsane*, (or, the brighter , bearer of dawn) as seen at sunrise – the forerunner of night or day time.

Figure 4. A NASA image showing the relative sizes of Mercury, Venus, Earth, and Mars, shown respectively from left to right.

4. References

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