Madawaska Highlands Observatory
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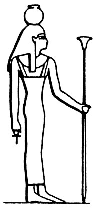

A Short List of Observing Projects

This list is not comprehensive or exclusive, it is meant to give an idea of what kind of astronomy can be done with the Wide-Field Telescope at the Madawaska Highlands Observatory.

The wide-field telescope is exclusively an imaging instrument, located under the exceptionally dark skies of the Madawaska Highlands of Ontario, and equipped with the latest innovations, cameras, and optimized for the sharpest possible images, state-of-the-art in every respect. Although designed primarily has a wide field instrument, it is capable of taking superb images of the planets etc. The telescope has a world leading field-of-view (FOV) thus many of the astronomy suggested utilizes the feature. The instrument can also go very deep (faint) and some observations utilize both features.

The Wide-Field Telescope because of its extremely wide FOV and its ability to detect very faint stars will offer unprecedented images of the night sky. The images produced by the OMI will surely be world class and surpass by a vast margin anything that amateur astronomers have produced so far. Indeed we expect images from the One Meter Initiative to rival almost anything in existence in terms of wide field imaging

In addition to learning about are universe, there is a real potential to make important contributions to science and astronomy.

1. Solar system

a) The planets offer a wonderful opportunity to see our nearby neighbors in all their splendor. Direct imaging of the planets is very satisfying. Using the guide sensors medium resolution (0.46”/pixel) can be used to study the dust storms on Mars and feature changes and Jupiter and Saturn etc.

b) Measuring the rotation of planets. This is done is by taking a successive series of images, measuring the angular rotation of selected features. The gas planets, Jupiter, Saturn etc, offer the opportunity to see the differential rotation of the different belt zones.

c) Measuring the rotation of asteroids. This can be achieved by taking a series of images of a particular asteroid and measuring its brightness changes. The changes are fairly rapid from a few minutes to hours.

d) Searching for asteroids and Kuiper Belt Objects (KBO). This is achieved by looking for a moving object, usually near the ecliptic. The technique involves starring at an area for a few seconds to a minute and returning an hour or so later to see if any objects have moved. KBO’s are objects beyond the orbit of Pluto. Sometimes objects have highly inclined orbits, thus searches beyond the elliptic may also prove successful.

e) Searches for comets. These can be found anywhere in the sky, although the periods immediately after evening twilight and beginning of morning twilight offer the best opportunities. The comet is named after the discoverer.

f) Searching for planetary satellites. With its wide FOV and deep limiting magnitude the OMI is well suited to find faint satellites of the planets. These would be very small (faint) and distant (> 1 degree) from the main body.

g) Lunar study. The moon is bright and close and can be studied in great detail.

h) Calculating orbital elements. By observing asteroids over a period of time it is possible to calculate the orbital elements and predict the position of the bodies.

2. Our Galaxy

a) Searching for faint red-dwarf and brown dwarf stars. These stars are very faint and form some 85% of the total stars of our galaxy. Thus they are very important to our understanding and evolution of the Milky Way.

b) Searching for light echo's from supernovae. These are rather large objects and well suited to for this instrument. Since most of our Galaxy is obscured by gas and dust, galactic supernovae are hidden from us. Current research indicates that 1 supernova should appear in our Galaxy per century, yet we have not seen one in over 400 years. Light echoes is one way to search for them.

c) Studying variables stars in remote open and globular clusters. Certain types of variable stars have an intrinsic link with their period and luminosity; Cepheids and RR Lyrae are among the most important. These stars can be used to calibrate the Milky Way in terms of size and thus mass. Cepheids are also very important in cosmological distance ladder. And a better understanding of these stars will help with the cosmological distance scale.

d) Searching for faint globular clusters orbiting the Milky Way. These distant objects are critical in the study of our Galaxy. They help pin down its mass, shape size and composition. They orbit the centre of the Galaxy and can be found several hundred thousand light years away. Of the 158 know globulars the vast majority are found near Sagittarius, in the area of the galactic centre. Possibly several hundred globulars orbit the Milky Way.

e) High proper motion stars. These are stars with a degree of apparent motion relative to the background stars. They are usually close to us and have inclined orbits to the plane of Galaxy. Barnard's star is one of these. To see one of these stars move is fascinating, this can be detected in images only a few months apart.

f) Nearby stars. These stars are relatively nearby, < 100 l.y., and can be observed by either their proper motion or a relative shift taken in images 6 months apart, on opposite sides of the Earth's orbit around the sun. Most likely these stars will be very faint (< mag 19) and be of the red dwarf category. With its ultra wide FOV and deep limiting magnitude is well suited for this task.

g) Discovering new variable stars. Although the vast majority of bright variable stars (> mag 15) have been discovered, almost none of the very faint one have been cataloged. This represents a rich opportunity to add to this body of science. Some have short periods, a few hours, while others have periods of years or centuries.

h) Supernovae remnants. These are large somewhat circular remnants of stars that have exploded. They glow from the strong ultra violet light of the remnant neutron star or pulsar. The filaments can be extremely faint and cover several degrees.

i) Probing the rich star clouds. Near the centre of our galaxy, in the Sagittarius and Scutum area are vast star clouds with millions of stars in a small area. Probing these star clouds with the wide FOV and deep limiting magnitude is bound to reveal new information; such has new variables, red dwarf stars, and even possibly new planets.

j) Probing the galactic halo. It is well known that the Milky Way main disk is about 100,000 light years across and about 2,000 light years thick. There is a vast halo that stretches 100's of thousands of light years beyond the main disc. This is the area of the globular clusters and the high inclination stars. Little is known about this vast volume of space.

k) Long term photometry. Measuring the brightness of stars over a long period of time is vital to our understanding of stellar evolution. These stars have to been monitored over a period of years.

l) Low resolution spectroscopy and classification. The ugriz filters can be used as a low resolution spectroscope to classify stars and nebula.

m) Faint star count. The wide FOV and deep limiting magnitude can be used to star counts. This will help in the study of our Galaxy.

n) Pulsars. The wide FOV and deep limiting magnitude allows the detection of optical pulsars. The OMI camera can do short exposures and thus can detect pulsars with periods of a few seconds to a few minutes. This will benefit our understanding of stellar evolution and the life cycle of stars.

o) Flare stars. Young red dwarf stars can emit powerful flares. The wide FOV allows monitoring thousands of stars simultaneously.

p) Planetary nebula. These are shells of gas that are luminous from the radiation of its host star. Planetary nebula can range in size to tens of minutes to less than an arc second. The central star is often visible. The

OMI with its faint limiting magnitude and wide FOV should be able to discover many planetary nebulae.

q) Microlensing. This effect relies on gravitational lensing where the light of a distant source is bent by a dense foreground object, such as a white dwarf, red dwarf, neutron star, black hole, planets, and Massive Compact Halo Objects. The technique is ideal to study the galactic population of these faint objects.

3. The Local Group and the nearby extra-galactic neighborhood

a) Extra-Galactic Cepheids. These are extremely important to astronomy. They allowed Edwin Hubble in 1923 to determine for the first time extra-galactic nature of spiral nebulae and revealed the true nature of our universe, that our Milky Way was but one of an almost infinite of number galaxies. The spiral in question was M31, the Great Andromeda Galaxy. Edwin Hubble measured the light curve of a particularly type of bright star, a Cepheid, and determined that these stars, by exploiting Shapley's distance measuring technique, was at least 1 million light years away. 3 times bigger than the entire universe was believed to be at that time! Cepheids are very bright stars, which can be observed across millions of light years and have a light curve that is strongly correlated with its brightness. By using this technique it is possible to measure distances of several 10's of millions of light years. The OMI can repeat this very important observation and directly measure the distance to M31 and other nearby galaxies.

b) Extra-galactic novae. The wide FOV and deep limiting magnitude can observe entire galaxies and search for novae in these galaxies. Novae are believed to be white dwarf stars that accrete hydrogen from a companion and after a critical mass accretion is exceeded a run-away thermonuclear explosion occurs where the excess mass is 'burned' with a brightening of over million times, the star eventually returns to its original brightness. This implies, of course that novae are recurring, with periods of 1,000 to 100,000 years. Astronomers estimate that the Milky Way experiences 30-60 novae per year. Novae can be used to measure distance to galaxies.

c) Companions to our Galaxy. It is well suited to discovering large and faint companion galaxies to our Milky Way. Some 30 are known to exist; all are small irregular galaxies that orbit our Galaxy up to distances of several hundred thousand light years or more. The stars are exceedingly faint and can cover the better part of a degree or more. The stars in these small galaxies can be fainter than magnitude 23 and well within its range.

d) Extra-galactic variables. Beyond the Cepheids there is a broad range of variables that can be observed in the Local group, such as RR Lyrae. These are very faint < mag 22.

e) Extra-galactic globulars. All galaxies have globular star clusters. These are clusters of stars held together by gravity and whose members may number from a few thousands to millions. They generally have a spheroid shape and orbit the centre of galaxies, but can swing far beyond the central mass or disc. M31 contains at least 500 globulars and our Galaxy has some 158 identified.

f) Open clusters and stellar associations. The brighter members can be observed in the local group and are sometimes associated with HII, and reflection nebula. Some of these objects can be very large with individual members resolved.

g) Star clouds and spiral structure. The monolithic 5 degress^2 is excellent for studying the immense star clouds and spiral structure of nearby galaxies, able to resolve large numbers of individual stars. Indeed the dust lanes and can be traced to near the galactic core of some of these galaxies.

h) HII regions. These areas are usually rich in stars in glow brightly in the Ha. They appear red in photographs and are a good indicator of the rate of star formation within a galaxy, it will be able to image a great many of the HII areas in the local group.

i) Supernovae. With its large FOV and deep limiting magnitude the OMI could observe all the major members of the local group in one night down to magnitude 25. Any supernova brighter than this would be detected.

j) Probing the halos of the local group. With its extremely wide FOV and deep limiting magnitude it could probe the halos of the nearby local group members. This would aid in our understanding of galaxies in general and the local group in particular.

4. The distant universe and cosmology

a) Supernovae. The large FOV and deep limiting magnitude it could detect over 100 supernovae per night and thousands per year. The wide FOV together with its deep limiting magnitude make this possible. These discoveries would have cosmological significance because SNe are used as standard distance candles. Thus they are key in determining the mass, age, size, density and evolution of the universe.

b) Gravitational Lensing and Einstein rings. Einstein predicted that mass could bend light. By observing these 'bent light' phenomena, which appear as rings, the intervening unseen mass density can be studied.

c) Galactic morphology. With its wide FOV can image thousands of galaxies and study galactic morphology that is the shape and structure of galaxies.

d) Low resolution spectral analysis. By using the ugriz filters it is possible to do a low resolution analysis of galaxies and supernovae.

e) Galaxy counts. By doing a deep exposure the with its large FOV galaxy counts can be done to study to distance universe and aid in the study of cosmology.

f) Clusters and Super-clusters of galaxies. These are the largest components of the universe held together by gravity. The 5 square degrees FOV is well suited to this type of observation. The clusters can span 10 or more degrees and are difficult if not impossible to study with current telescopes.

g) Gamma ray burst (GRB). These are though to be the most powerful events in the universe. The GRB is often associated with a visible burst; the wide field is excellent for studying this type of phenomena.