The Nibirum Solar System

The Solar System for Nibirum was constructed partly from parameters established earlier for the Community Atlas world, such as the physical size of Nibirum's globe, partly from comments on the ProFantasy Forum as to what people would like to have present in the System, and partly from the random system design tables in Galactic Baroque's "Instant Universe" book, available as a PDF via DriveThru RPG here:

http://www.drivethrurpg.com/product/153512/Instant-Universe?manufacturers_id=8711

From this process, details for seven main planets, their satellites and the System's Sun were established, with Nibirum featuring as the third planet out from that Sun. A chart and five maps were prepared to illustrate the various features thus discovered. Not all the information provided on these can be discerned from Nibirum. It is given instead both for completeness, and for those who may wish to include the possibility of magical transport to the other worlds around Nibirum in their fantasy RPG campaigns.

Note that only SI units have been used throughout, primarily for distances, sizes and masses, and that most such values have been rounded-off for simplicity. To a rough approximation, a metric tonne is about the same as an imperial ton, while to convert kilometres to miles, divide by 1.6 similarly.

Solar System Chart

This provides a size comparison between the seven planets, and shows their orbits around Nibirum's Sun to-scale, although two different scales were needed to condense everything onto one chart. At the scale of the orbital distances, even the Sun would have been just a tiny dot otherwise. A few basic details concerning each object are provided on this diagram too.

Planet Maps

Aside from the Inner Planets Map, which gives details for the Sun and the three innermost planets, Firebird, Daystar and Nibirum, the remaining four Planet Maps each detail just a single planet further from the Sun than Nibirum. In order outwards, these are Yellowstar, Goldenstar, Timekeeper and Trickster. All natural satellites and other accompanists for the planets are depicted, using various scales. Commonly, the planet and moon graphics are representational only, as for the scales needed, they would be otherwise too small to see usefully.

The orbits are illustrated as if looking down directly onto their north poles, so appear as circles surrounding the Sun or main planet involved, though they may be sometimes inclined slightly to each other in this imaginary actuality. Arrows show the direction of motion of the planets on their solar orbits, and the satellites in orbit around their own planet. The axial rotation direction for the main planets (only) is indicated by an arrowed arc for each. Satellite axial rotation directions are the same as that of their planet.

Descriptive texts provide physical details for the objects shown, which are repeated for clarity in this PDF document along with a few extra notes and explanations. Names for the planets vary between different Nibirese cultures, hence only some of the commoner ones have been employed here, chiefly those that are based upon the object's appearance and/or its behaviour as detectable from Nibirum.

Note that no planet shows a discernible disc to the unaided eye from Nibirum. All simply appear as bright to brilliant stars. No satellites other than Nibirum's own are visible from that planet either, except sometimes for the co-orbital small comets of the Dawn Heralds.

Object Summaries

Sun: A spectral class G3 star. Diameter: 1,400,000 km (about 110 times the size of Nibirum). Angular size from Nibirum: 0.62° (Earth's Sun is about 0.5° from Earth). Similar to Earth's Sun in mass, colour and brightness, it shows darker spots on its surface from time to time. It also emits a solar wind capable of producing aurorae on any planets with a strong enough magnetic field. At Nibirum, this solar wind generates regular polar aurorae, and occasional mid-latitude auroral sub-storms, again much as happens on Earth.

Planet I - Firebird: The innermost known planet, orbiting at 67 million km from the Sun. A metal dwarf planet (so mostly composed of dense, iron-rich substances, with little silicate rocky material, and no real atmosphere), it has 0.035 Nibirum's mass and a 3,500 km diameter. This makes it the smallest planet in the Nibirran Solar System. Its has a day length of 210 Nibirran hours, a year length of 120 Nibirran days, an axial tilt of 19° from the vertical, and an inclination to the ecliptic of 3°. Its surface gravity is about 45% that of Nibirum, and it has no natural satellites. From Nibirum, it appears as a pink star, never more than 30° away from the Sun in the sky. Using the usual Earthly magnitude scale for describing the brightness of celestial objects (see *Appendix A* on page 8 of this document), Firebird ranges from magnitude -2.5, when only 15° or so from the Sun around its closest to Nibirum (sufficiently powerful magical or optical aid then would show Firebird to have a crescent phase), through -2 when *circa* 30° from the Sun (half phase), to -1 when near the opposite side of the Sun from Nibirum (full phase, albeit visible then primarily during a total solar eclipse for Nibirum, due to its proximity to the Sun in the sky). Others of its Nibirese names involve its quick, often hidden, movement, and its nearness to the Sun, such as "Moth".

Planet II - Daystar: Distance from the Sun: 87 million km. A giant water world, possessing a global ocean and a relatively dense atmosphere, with just a few, small, rocky landmasses, a rocky core, and little metal in its makeup overall. It has 7 Nibirum masses and a 30,600 km diameter. Its day length is the same as its year, 150 Nibirran days. Its axial tilt is 3° and its inclination to the ecliptic is 0°. Its surface gravity is 120% that of Nibirum, and it has two dwarf moons. From Nibirum, Daystar has a distinct blue-green, star-like appearance, and it always lies within 44° of the Sun in the sky. Its magnitude range is quite small, varying from about -10, when closest to both Nibirum and the Sun in Nibirum's sky (at a distance of 15° from the Sun, and showing a slender crescent phase with optical or magical viewing aids then), to -10.5 at most other times, including when it is at its greatest elongation from the Sun, 44° (half phase), and when it is close to being on the far side of the Sun for Nibirum. Such brilliance (comparable to the first or last quarter Moon in Earth's sky, though condensed into a tiny dot) means it can be quite

readily seen as a bright star by those who know just where to look, even in a clear, noontide sky. Its common names centre around its brilliance, striking colour, and sometimes its sky-location, including Blue Lamp or Lantern, Morning or Evening Sun, or Twilight Sun.

Inner Moon: Metal body. Orbits at 300,000 km from Daystar. 0.0000021 Nibirum's mass. 260 km diameter. Day length = orbital period: 19 Nibirran days. Axial tilt: 4°. Ecliptic inclination: 2°.

Outer Moon: Rock body. Orbits at 450,000 km from Daystar. 0.00000067 Nibirum's mass. 230 km diameter. Day length = orbital period: 35 Nibirran days. Axial tilt: 16°. Ecliptic inclination: 0°.

Planet III - Nibirum: Its distance from the Sun, 130 million km, is around 87% that of Earth's from its Sun, but the two are otherwise fairly alike. Nibirum is a rocky planet, thus has a metallic core (mostly of iron) surrounded by silicate minerals and some metals, with a moderate atmosphere and a normal-strength magnetic field. Its mass is 6×10^{21} (6,000,000,000,000,000,000,000) tonnes, and its diameter is 12,800 km. Its day length is 24 hours, while its year lasts 360 of these days. It has an axial tilt of 25°, and an inclination to the ecliptic of 0°. Its surface gravity is essentially identical to Earth's. It has one major and one dwarf moon.

Major Moon: Often called the White Moon, Silver Moon or Pale Moon from its cream-grey colouring, or the ☽ Moon (the latter only from the planet's southern hemisphere, by those who recognise a symbol of "☽" form, which shape is interpreted as being set on the Moon's face). It shows phases from Nibirum just like Earth's Moon from Earth. It is a rock body that orbits at 200,000 km from Nibirum. It has 0.014 Nibirum's mass and a diameter of 2,130 km. It always keeps the same face pointing towards Nibirum, as its day length is the same as it orbital period, 24 Nibirran days. Its axial tilt is 0° and its ecliptic inclination is 4°. Its angular size from Nibirum varies slightly between 0.61° to 0.63° (Earth's Moon has an average angular size of about 0.5°). Its surface gravity is just 5% that of Nibirum. Its brightness is comparable to that of Earth's Moon.

Dwarf Moon: Usually known as the Red or Dog Moon, from its colouring, and the fact it faithfully follows after the White Moon in Nibirum's sky by 60°. It lies at the trailing (L5) ***Lagrange point**** on the White Moon's orbit, 200,000 km from Nibirum. It is a rock body that has a distinctive dull red surface. For a period of about 6 to 8 Nibirran days centred on its closest to the Sun in its 24-day orbit as viewed from the planet (again like the White Moon, its Nibirran orbital period is the same length as its day), it generally cannot be seen at all. Outside this interval, it remains visible as a tiny, faint disc when in the night sky. It is too faint to be seen in strong twilight or the daytime sky, as its magnitude is only about +3. It has 0.0000015 Nibirum's mass, and a diameter of 350 km. This gives it an angular size in Nibirum's sky of about 0.1°. Curiously, for reasons unknown to the Nibirese, it does not show phases like the White Moon, even when using

* **Lagrange points:** The L4 and L5 Lagrange points on a body's orbit are gravitationally relatively stable points where small objects can become caught for very long periods (lasting centuries to millennia). The pre-existing space-motions of such objects mean they usually continue to orbit about that stable point, so are not necessarily "fixed" in one spot. Each point lies more or less at 60° along the orbit from the body on it, the L4 point ahead of the body on its orbit, the L5 point behind it. The Lagrange point (and any object near it) also forms an equilateral triangle both with the body on the same orbit, forming two apices, and with the larger body both are orbiting - such as the Sun, or a major planet - at the third apex. In turn, this also means that the Lagrange point is the same physical distance from the body it is co-orbital with, and with the object both are orbiting. Thus the Dog Moon is 200,000 km from both Nibirum and the White Moon at all times, and from any of the three bodies, the other two are always about 60° apart in the sky.

optical or magical aid to view it (this size is just large enough for it to be glimpsed as a disc with normal human vision, which can resolve objects down to about 0.07°). Its axial tilt is 0° and its ecliptic inclination 4°. Its surface gravity is 0.2% of Nibirum's.

Dawn Heralds: A variably-sized group of small asteroidal and cometary bodies, co-orbital with Nibirum at the leading (L4) Lagrange point, 60° ahead of Nibirum on its orbit (see the boxed text on page 3 for an explanation of the Lagrange points). At times, the cometary activity from this group is sufficient to be seen from Nibirum. If so, it usually takes the form of a misty nebulosity in which lie one or more star-like brighter objects (of 4th and 5th magnitude, now and again as bright as 3rd). Occasionally, these brighter bodies can take on the form of tiny comets too. The shape, character and day-to-day changes in this misty group are commonly seen as omens, including when nothing can be seen of it. The group orbits at 130 million km from both the Sun and Nibirum. Collectively, they occupy a region about 1 to 3½ million km across. So from Nibirum, their angular size is *circa* 0.5° to 1.5°. (This is roughly the same as the angular size of the 8 or 9 4th and 5th magnitude stars, plus one star of 3rd magnitude, in the Earth-visible Pleiades, or Seven Sisters, star cluster in the constellation of Taurus the Bull, about 1° east-west by 0.7° north-south. The Pleiades are a surprisingly easy object to the unaided eye in even quite strong twilight, the group of faint stars in close proximity making them easier to spot than their individual brightnesses alone might suggest.) When visible, the Dawn Heralds can be seen near the ecliptic in the morning sky before sunrise around 60° from the Sun. Their other Nibirese names include The Morning, or Golden, Mist, or The Dawn Portents.

Additional Lore: The L5, trailing, Lagrange point on Nibirum's orbit is apparently "empty" - at least of anything visible from the surface of Nibirum - and some Nibirran scholars seeking symmetry in such things have tried various explanations for this phenomenon. So maybe the misty stars of the Dawn Heralds shine showing the approaching richness (or otherwise if not visible) of the magical-mystical potential into which Nibirum will soon be moving (with a 360-day year, 60° = 60 days on Nibirum). That there is no equivalent visible group of "Dusk Heralds" could be interpreted as meaning that potential has been exhausted by the passage of the magical world of Nibirum, and will take much time - most of a year, say - to recover. However, the Dog Moon fitting into the trailing Lagrange point on the White Moon's orbit has been taken by others as completing the "missing" Dawn Heralds symmetry instead. The whole matter remains unresolved. Of course, for RPG GMs, the Dawn Heralds can be a useful plot-device!

Planet IV - Yellowstar: A giant rock planet orbiting at 170 million km from the Sun. It has 6 Nibirum masses, and a 20,400 km diameter. It has a thick silicate crust, but it remains a geologically-active planet with a normal magnetic field and a thick atmosphere. Its day lasts 23 Nibirran hours, and its year 450 Nibirran days. Its axial tilt is 12° and its inclination to the ecliptic is 2°. Its surface gravity is 230% that of Nibirum. It has one major moon and 19 tiny moons, five orbiting closer to the planet than the major moon, the remaining 14 in a clustered group close to the same orbit as one another much further from Yellowstar. As seen from Nibirum the planet has a yellow-white colour and a star-like appearance. Its brightness varies slowly depending on its current distance from Nibirum, between magnitude -4.5 when near the opposite side of the Sun from Nibirum, to -7 when at its closest and highest in Nibirum's midnight sky. This brilliance means that providing the observer knows just where to look, it is nearly always possible to spot Yellowstar, even in the daytime. As it is quite similar in appearance to the next most distant planet, the two are often considered twins for the Nibirese, told apart chiefly by the

relative speed of their changing positions against the stars. So Yellowstar can be called instead the Fast Night Sun, or the quicker of The Twin Suns of Night, or The Twin (Golden) Stars.

Five Inner Tiny Moons: All have a tidally-locked rotation period, so their orbital periods are the same as their day lengths. They also have axial tilt and ecliptic inclinations of 0°. In the following table, "Distance" is from Yellowstar, "Mass" is compared to Nibirum = 1, and "hours" and "days" mean Nibirran ones.

Moon	Type	Distance	Mass	Diameter	Orbital Period
1	Rock	51,000 km	0.00001	440 km	31 hours
2	Ice	87,000 km	0.00007	640 km	3 days
3	Metal	147,000 km	0.00001	380 km	7 days
4	Metal	250,000 km	0.00002	440 km	15 days
5	Ice	376,000 km	0.000004	760 km	27 days

Major Moon: An ice body with a significant atmosphere and some surface and subsurface liquid seas. It orbits at 640,000 km from its parent planet, has 0.008 Nibirum's mass, and a diameter of 1,780 km. Its day length and orbital period are tidally-locked, at 60 Nibirran days. Its axial tilt and ecliptic inclination are both 0°.

Outer Tiny Moons (14): All lie close to the same mean orbit, at 1,215,000 km from Yellowstar, which orbit has an ecliptic inclination of 3°. They form a loose, strung-out group along roughly 25° of this orbit, an actual separation between the leading (1) to trailing (14) moons of approximately 540,000 km. Any given member of this swarm takes 157 Nibirran days to orbit their parent planet once. In the following table, "Mass" is as compared to Nibirum = 1.

Moon	Type	Mass	Diameter		Moon	Type	Mass	Diameter
1	Rock	0.00002	510 km		8	Ice	0.0001	1,020 km
2	Rock	0.000008	380 km		9	Ice	0.00002	640 km
3	Rock	0.000003	320 km		10	Rock	0.00001	440 km
4	Ice	0.000004	450 km		11	Rock	0.0001	760 km
5	Rock	0.000006	380 km		12	Rock	0.00001	440 km
6	Ice	0.0002	1,280 km		13	Rock	0.000002	320 km
7	Rock	0.000004	380 km		14	Rock	0.00004	640 km

Planet V - Goldenstar: The largest known planet in the Nibirum Solar System, this ringed gas giant orbits the Sun at 305 million km. It has 72 Nibirum masses, and a diameter of 120,000 km. It spins rapidly on its axis, with a day only 5 Nibirran hours long, which also leads to it having a high temperature in its thick atmosphere. This gas surrounds a liquid metallic hydrogen interior, at the centre of which is a molten silicate core. It has an unusually weak magnetic field. Its year is 1,080 Nibirran days long. It has an axial tilt of 2° and an ecliptic inclination of 0°. It is surrounded by a ring system of dust, ice and gas, with 4 tiny moonlets amongst the rings. Beyond those orbit 5 major moons. From Nibirum, the planet seems a golden-yellow star, similar to its immediately inner neighbour, hence the Nibirese often perceive them as twins - The Twin Night Suns or Twin (Golden) Stars. This one, being the more distant from Nibirum, seems to travel around the Nibirran sky less quickly, so it can be called The Slow Night Sun too. Its magnitude range is also similar to that of Yellowstar, from -5 to -7 when furthest from and closest to

Nibirum respectively. Like Yellowstar, this also means Goldenstar is brilliant enough to be glimpsed even in full daylight by those knowing exactly where to look.

Rings: Their inner edge lies at 120,000 km from the planet, the outer at 228,000 km. Seen as edge-on from Nibirum. All four moonlets within the rings are tiny ice bodies:

Moonlet	Mass (tonnes)	Diameter
1	3 million-million	80 km
2	2 million-million	50 km
3	670 thousand-million	40 km
4	1 million-million	40 km

Major Moon 1: Ice body. 265,000 km from Goldenstar. 0.003 Nibirum's mass. 2,560 km diameter. Like all of Goldenstar's major moons, it has a tidally-locked rotation, so its day length and orbital period are the same, in this case of 16 Nibirran days. Axial tilt: 29°. Ecliptic inclination: 3°. Surface gravity: 7% of Nibirum's.

Major Moon 2: Ice body. 500,000 km from Goldenstar. 0.003 Nibirum's mass. 2,560 km diameter. Day length & orbital period: 42 Nibirran days. Axial tilt: 31°. Ecliptic inclination: 0°. Surface gravity: 5% of Nibirum's.

Major Moon 3: Ice body. 755,000 km from Goldenstar. 0.006 Nibirum's mass. 3,320 km diameter. Day length & orbital period: 77 Nibirran days. Axial tilt: 21°. Ecliptic inclination: 0°. Surface gravity: 9% of Nibirum's.

Major Moon 4: Ice body. 1,360,000 km from Goldenstar. 0.0025 Nibirum's mass. 2,680 km diameter. Day length & orbital period: 186 Nibirran days. Axial tilt: 23°. Ecliptic inclination: 1°. Surface gravity: 6% of Nibirum's.

Major Moon 5: Rock body. 2,450,000 km from Goldenstar. 0.0006 Nibirum's mass. 1,280 km diameter. Day length & orbital period: 450 Nibirran days. Axial tilt: 6°. Ecliptic inclination: 0°. Surface gravity: 6% of Nibirum's.

Planet VI - Timekeeper: An ice planet orbiting at 400 million km from the Sun, although more accurately, it might be considered a double planet with its near-orbiting giant moon - the latter substantially larger than the innermost planet Firebird. Timekeeper has 2.2 Nibirum masses and a 19,600 km diameter. It has surface gravity 94% of Nibirum's, and a normal magnetic field. Tidal stresses created with its giant moon help both worlds remain geologically active. Ice bodies typically have a water-ice mantle with some ammonia, methane and other volatiles, surrounding a rocky, silicate, core, with this pair also each possessing subsurface liquid oceans, protected by a thick, frozen icy crust. Ice and water volcanoes can be found on both worlds, with other eruptive features from time to time. Timekeeper has an unusual resonant axial rotation period, so its day length, 520 Nibirran days, is one-third of its year, 1,560 Nibirran days. Its axial tilt is 24° and its inclination to the ecliptic is 0°. Aside from its giant moon, it also has two more distant dwarf moons. As seen from Nibirum, Timekeeper is a blue-white star, whose brightness seems to remain stable over long periods. Its magnitude varies from +1 when furthest from Nibirum - near the far side of the Sun - to -0.5 when closer to Nibirum, and highest in the midnight sky. Consequently, its commoner names tend to reflect this perceived quiet stability and seeming stateliness, such as The Pacer or Old Faithful.

Giant Moon: An ice body, it is geologically active in conjunction with its parent planet, as noted above. It orbits just 32,000 km from Timekeeper. It has 0.1 Nibirum's mass and a diameter of 7,660 km. Tidally-locked, its day length and orbital period are the

same at only 17 Nibirran hours. Its axial tilt is 6°, its ecliptic inclination 3°, and its surface gravity is 28% that of Nibirum.

Inner Dwarf Moon: Ice body. 55,000 km from Timekeeper. 0.0000006 Nibirum's mass. 270 km diameter. Day length = orbital period: 36 Nibirran hours. Axial tilt: 23°. Ecliptic inclination: 0°.

Outer Dwarf Moon: Ice body. 71,000 km from Timekeeper. 0.0000008 Nibirum's mass. 290 km diameter. Day length = orbital period: 53 Nibirran hours. Axial tilt: 13°. Ecliptic inclination: 0°.

Planet VII - Trickster: The outermost known planet in the Nibirum System, Trickster is a ringed ice giant world of some 7 Nibirum masses, and a diameter of 74,000 km, orbiting at 595 million km from the Sun. It has an abnormally great axial tilt of 41°, which means sometimes its rings are edge-on to Nibirum, at other times much better displayed. Although the planet is only a green-white star-dot as seen from Nibirum, this changing rings-angle means the planet's brightness varies quite considerably. At its furthest from Nibirum, when near the far side of the Sun, it can seem as relatively faint as magnitude -2 with edge-on rings, to -4 if its rings are well on-view. When closest to Nibirum and highest in the sky around midnight, its brightness range is between -3 (no rings) to -5 (open rings). At its very brightest (only), it can be seen even in daylight, as long as the witness knows exactly where to look. Such variability, coupled with its colouring, have led to its commoner names frequently being linked to inconstancy and unreliability, such as The Illusionist. Its inclination to the ecliptic is 0°, its day lasts 130 Nibirran hours, and its year is 2,880 Nibirran days long. Its surface gravity is 21% of Nibirum's. It has an extensive dust-ice ring system, within which orbit 6 tiny moonlets, and there are 3 major moons additionally. As an ice giant planet, Trickster has a dense layer of frozen hydrogen and helium that crushes its underlying ices into an ionized liquid that generates a particularly strong magnetic field. Like other ice worlds, this ocean and its ices overlie a rocky core.

Rings: The inner edge is at 220,000 km from Trickster, the outer at 377,000 km. Five of the six ring moonlets are tiny ice bodies; moonlet 4 is rocky instead.

Moonlet	Mass (tonnes)	Diameter
1	3 million-million	60 km
2	546 thousand-million	40 km
3	1,500 million-million	60 km
4	1,500 million-million	40 km
5	840 thousand-million	40 km
6	1,000 million-million	50 km

Major Moon 1: Ice body. 400,000 km from Trickster. 0.001 Nibirum's mass. 1,920 km diameter. Day length = orbital period: 30 Nibirran days. Axial tilt: 28°. Ecliptic inclination: 4°. Surface gravity: 4% of Nibirum's.

Major Moon 2: Ice body. 760,000 km from Trickster. 0.0027 Nibirum's mass. 1,280 km diameter. Day length = orbital period: 78 Nibirran days. Axial tilt: 6°. Ecliptic inclination: 0°. Surface gravity: 27% of Nibirum's.

Major Moon 3: Ice body. 1,215,000 km from Trickster. 0.0011 Nibirum's mass. 1,920 km diameter. Day length = orbital period: 157 Nibirran days. Axial tilt: 7°. Ecliptic inclination: 0°. Surface gravity: 7% of Nibirum's.

Appendix A: The Astronomical Magnitude Scale

The apparent brightness of objects in the night sky from Nibirum uses the standard Earthly magnitude scale. In this, 6th magnitude, or objects of magnitude +6, covers the very faintest objects visible to the normal human eye. The scale decreases numerically from there as the brightness of the objects increases (so 7th magnitude objects are usually too faint to be seen without optical aid, but those of magnitude +5 are easier to see than those of +6). Most of the brightest stars from Earth are of magnitude +1 and 0, with negative-magnitude objects being of especial brilliance, like the planets, the Moon and the Sun. Earth's Sun - and Nibirum's too - has an apparent magnitude of about -26, for example, brilliant enough to cause permanent eye damage if looked-at directly, even momentarily. For comparison, these are the magnitudes, rounded-off to the nearest 0.5, for the brighter Earthly objects:

Object	Magnitude
Sirius (brightest nocturnal star of all)	-1.5
Planet Jupiter (when brightest)	-3.0
Planet Venus (when brightest)	-4.5
Crescent Moon (4 or 24 days old)	-8.0
First or Last Quarter Moon	-10.0
Gibbous Moon (11 or 18 days old)	-11.5
Full Moon	-12.5

The magnitudes for the planets as seen from Nibirum were calculated using the formula:

$$5 \log_{10} \left(\frac{\text{Planet's distance from the Sun in AU x Planet's distance from Nibirum in AU}}{\sqrt{\text{Decimal phase}}} \right) + \text{BF}$$

Where:

"AU" = Astronomical Unit, the average distance between the Earth and its Sun. For simplicity, use 150 million km for this (the actual distance is 149,597,870 km).

"Decimal phase" = the percentage of the planet's disc illuminated, expressed as a decimal; so "full" is 1, "half" 0.5, and so on. Only planets closer to the Sun than Nibirum show much difference in phase. The outer planets can be generally thought of as showing full phase only, so this term can be often ignored (as the square root of 1 is 1).

"BF" = Brightness Factor, a value that takes into account both the reflectivity of the planet and its angular size at the standard distance of 1 AU from the observer. It is essentially the apparent brightness the planet would have at 1 AU. While these cannot be precisely determined for Nibirum, the values assigned after a comparison with the Brightness Factors for the planets in Earth's Solar System, were:

Planet	Brightness Factor
Firebird	-0.4
Daystar	-9.0
Yellowstar	-4.5
Goldenstar	-8.9
Timekeeper	-3.8
Trickster (rings closed)	-8.3
Trickster (rings fully open)	-10.5