

SIDEREAL MESSENGER  
unfolding great and very wonderful sights  
and displaying to the gaze of everyone,  
but especially philosophers and astronomers,  
the things that were observed by  
GALILEO GALILEI,  
Florentine patrician<sup>1</sup>  
and public mathematician of the University of Padua,  
with the help of a spyglass<sup>2</sup> lately devised<sup>3</sup> by him,  
about the face of the Moon, countless fixed stars,  
the Milky Way, nebulous stars,  
but especially about  
four planets  
flying around the star of Jupiter at unequal intervals  
and periods with wonderful swiftness;  
which, unknown by anyone until this day,  
the first author detected recently  
and decided to name  
MEDICEAN STARS<sup>4</sup>

Excerpts from The Starry Messenger, by  
Galileo Galilei, published in Venice, 1610

## ASTRONOMICAL MESSAGE

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Containing and Explaining Observations Recently Made,  
With the Benefit of a New Spyglass, About the  
Face of the Moon, the Milky Way, and Nebulous  
Stars, about Innumerable Fixed Stars and also Four  
Planets hitherto never seen, and named  
COSMIC STARS

In this short treatise I propose great things for inspection and contemplation by every explorer of Nature. Great, I say, because of the excellence of the things themselves, because of their newness, unheard of through the ages, and also because of the instrument with the benefit of which they make themselves manifest to our sight.

Certainly it is a great thing to add to the countless multitude of fixed stars visible hitherto by natural means and expose to our eyes innumerable others never seen before, which exceed tenfold the number of old and known ones.<sup>18</sup>

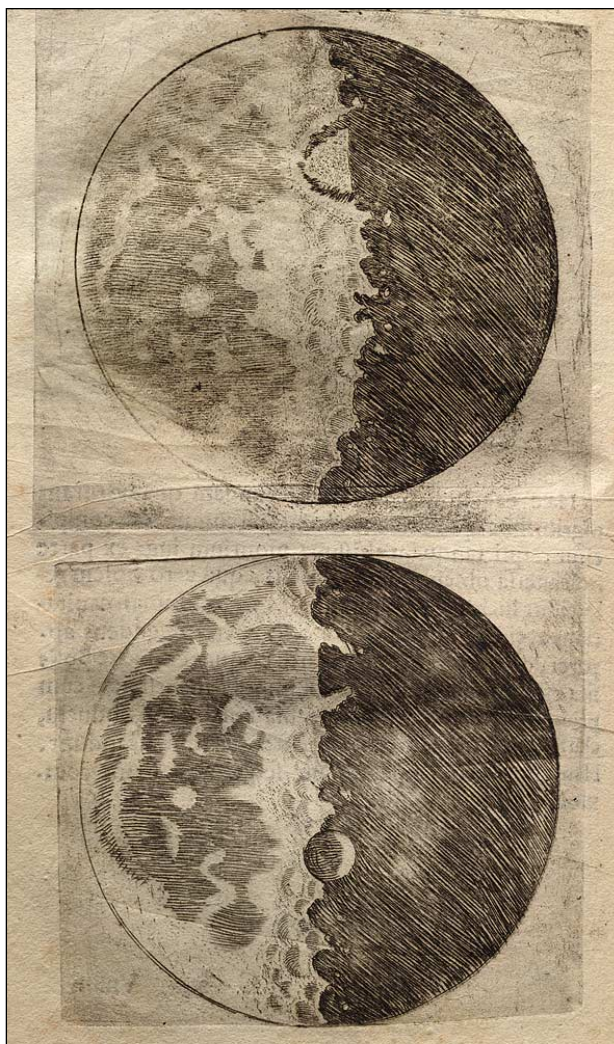
It is most beautiful and pleasing to the eye to look upon the lunar body, distant from us about sixty terrestrial diameters,<sup>19</sup> from so near as if

it were distant by only two of these measures, so that the diameter of the same Moon appears as if it were thirty times, the surface 900 times, and the solid body about 27,000 times larger than when observed only with the naked eye.<sup>20</sup> Anyone will then understand with the certainty of the senses that the Moon is by no means endowed with a smooth and polished surface, but is rough and uneven and, just as the face of the Earth itself, crowded everywhere with vast prominences, deep chasms, and convolutions.

Moreover, it seems of no small importance to have put an end to the debate about the Galaxy or Milky Way and to have made manifest its essence to the senses as well as the intellect; and it will be pleasing and most glorious to demonstrate clearly that the substance of those stars called nebulous up to now by all astronomers is very different from what has hitherto been thought.

But what greatly exceeds all admiration, and what especially impelled us to give notice to all astronomers and philosophers, is this, that we have discovered four wandering stars, known or observed by no one before us. These, like Venus and Mercury around the Sun,<sup>21</sup> have their periods around a certain star<sup>22</sup> notable among the number of known ones, and now precede, now follow, him, never digressing from him beyond certain limits. All these things were discovered and observed a few days ago by means of a glass contrived by me after I had been inspired by divine grace.

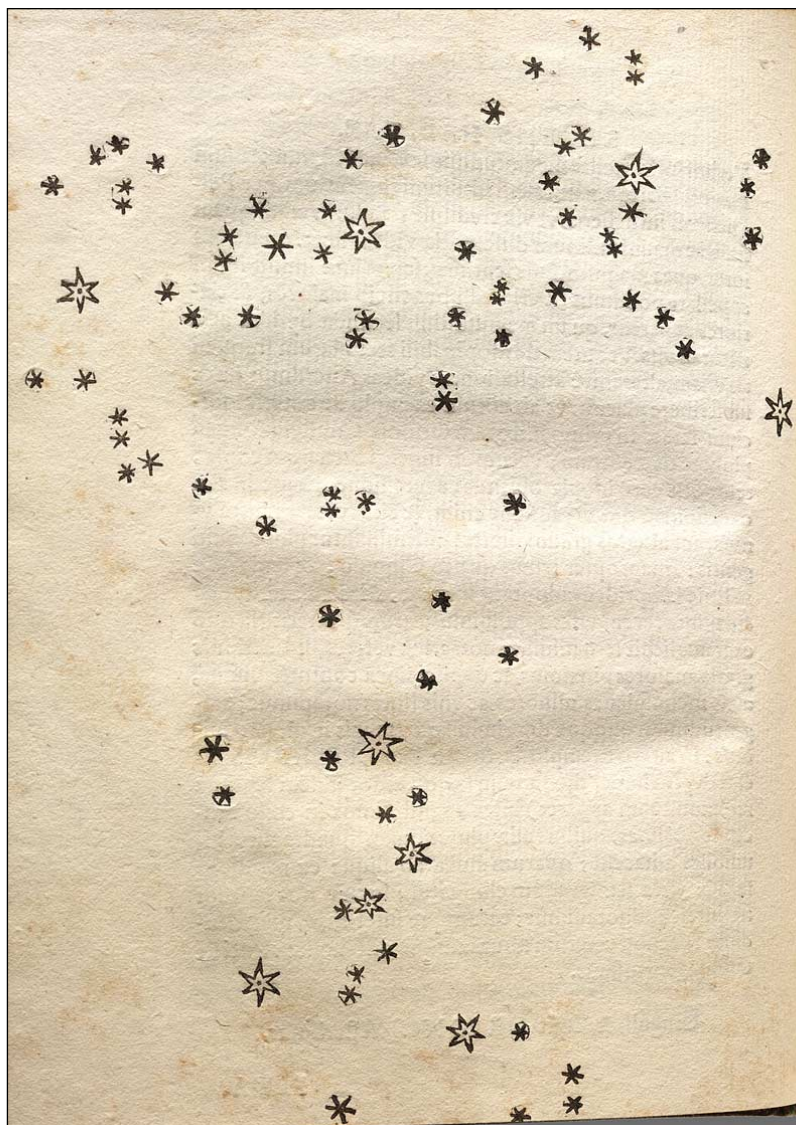
Perhaps more excellent things will be discovered in time, either by me or by others, with the help of a similar instrument, the form and construction of which, and the occasion of whose invention,



The first thing Galileo studies and writes about is the Moon and he deduces that the Moon has mountains, ridges, valleys, and craters. He uses geometry to estimate the height of the mountains and of the crater walls from their shadow lengths. Then he turns his telescope to many stars. Next he turns to the diffuse, nebulous Milky Way. Finally, he turns to Jupiter. The excerpts that follow are from far along in the publication. They are about the Milky Way (which we now know to be the edge-on view of our galaxy) and of Jupiter's Moons.

Indeed, with the glass you will detect below stars of the sixth magnitude such a crowd of others that escape natural sight that it is hardly believable. For you may see more than six further gradations of magnitude. The largest of these, which we may designate as of the seventh magnitude, or the first magnitude of the invisible ones, appear larger and brighter with the help of the glass than stars of the second magnitude seen with natural vision.<sup>57</sup> But in order that you may see one or two illustrations of the almost inconceivable crowd of them, and from their example form a judgment about the rest of them, I decided to reproduce two star groups. In the first I had decided to depict the entire constellation of Orion, but overwhelmed by the enormous multitude of stars and a lack of time, I put off this assault until another occasion.<sup>58</sup> For there are more than five hundred new stars around the old ones, spread over a space of 1 or 2 degrees. For this reason, to the three in Orion's belt and the six in his sword<sup>59</sup> that were observed long ago, I have added eighty others seen recently, and I have retained their separations as accurately as possible. For the sake of distinction, we have depicted the known or ancient ones larger and outlined by double lines, and the other inconspicuous ones smaller and outlined by single lines. We have also preserved the distinction in size as much as possible. In the second example we have depicted the six stars of the Bull<sup>60</sup> called the Pleiades (I say six since the seventh almost never appears)<sup>61</sup> contained within very narrow limits in the heavens. Near these lie more than forty other invisible stars, none of which is farther removed from the aforementioned six than scarcely half a degree. We have marked down only thirty-six of these, preserving their mutual distances, sizes, and the distinction between old and new ones, as in the case of Orion.





[Asterism of the belt and sword of Orion.]



[Constellation of the Pleiades.]

What was observed by us in the third place is the nature or matter of the Milky Way itself, which, with the aid of the spyglass, may be observed so well that all the disputes that for so many generations have vexed philosophers are destroyed by visible certainty, and we are liberated from wordy arguments.<sup>62</sup> For the Galaxy is nothing else than a congeries of innumerable stars distributed in clusters. To whatever region of it you direct your spyglass, an immense number of stars immediately offer themselves to view, of which very many appear rather large and very conspicuous but the multitude of small ones is truly unfathomable.

And since that milky luster, like whitish clouds, is seen not only in the Milky Way, but dispersed through the ether, many similarly colored patches shine weakly; if you direct a glass to any of them, you will meet with a dense crowd of stars.

Moreover—and what is even more remarkable—the stars that have been called “nebulous” by every single astronomer up to this day are swarms of small stars placed exceedingly closely together.<sup>63</sup> While each individual one escapes our sight because of its smallness or its very great distance from us, from the commingling of their rays arises that brightness ascribed up to now to a denser part of the heavens capable of reflecting the rays of the stars or Sun.<sup>64</sup> We have observed some of these, and we wanted to reproduce the asterisms of two of them.

In the first there is the nebula called Orion’s Head, in which we have counted twenty-one stars.<sup>65</sup>

The second figure contains the nebula called Praesepe, which is not a single star but a mass of more than forty little stars. In addition to the asscolts we have marked down thirty-six stars, arranged as follows:<sup>66</sup>

Nebula of Orion.



Nebula of Praesepe.





We have briefly explained our observations thus far about the Moon, the fixed stars, and the Milky Way. It remains for us to reveal and make known what appears to be most important in the present matter: four planets never seen from the beginning of the world right up to our day, the occasion of their discovery and observation, their positions, and the observations made over the past two months<sup>67</sup> concerning their behavior and changes. And I call on all astronomers to devote themselves to investigating and determining their periods. Because of the shortness of time, it has not been possible for us to achieve this so far.<sup>68</sup> We advise them again, however, that they will need a very accurate glass like the one we have described at the beginning of this account, lest they undertake such an investigation in vain.<sup>69</sup>

Accordingly, on the seventh day of January of the present year 1610,<sup>70</sup> at the first hour of the night, when I inspected the celestial constellations through a spyglass, Jupiter presented himself. And since I had prepared for myself a superlative instrument, I saw (which earlier had not happened because of the weakness of the other instruments) that three little stars were positioned near him—small but yet very bright. Although I believed them to be among the number of fixed stars, they nevertheless intrigued me because they appeared to be arranged exactly along a straight line and parallel to the ecliptic, and to be brighter than others of equal size. And their disposition among themselves and with respect to Jupiter was as follows:<sup>71</sup>

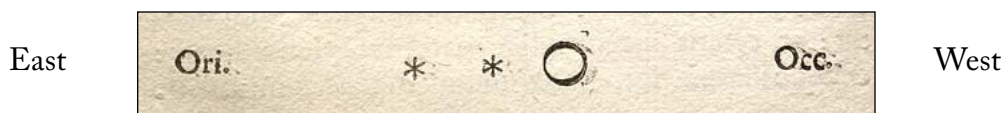


That is, two stars were near him on the east and one on the west; the more eastern one and the western one appeared a bit larger than the remaining one. I was not in the least concerned with their distances from Jupiter, for, as we said above, at first I believed them to be fixed stars. But when, on the eighth, I returned to the same observation, guided by I know not what fate, I found a very different arrangement. For all three little stars were to the west of Jupiter and closer to each other than the previous night, and separated by equal intervals, as shown in the adjoining sketch.<sup>72</sup> Even though at this point I had by no means turned my thought to the mutual motions of these stars,



yet I was aroused by the question of how Jupiter could be to the east of all the said fixed stars when the day before he had been to the west of two of them. I was afraid, therefore, that perhaps, contrary to the astronomical computations, his motion was direct and that, by his proper motion, he had bypassed those stars. For this reason I waited eagerly for the next night. But I was disappointed in my hope, for the sky was everywhere covered with clouds.

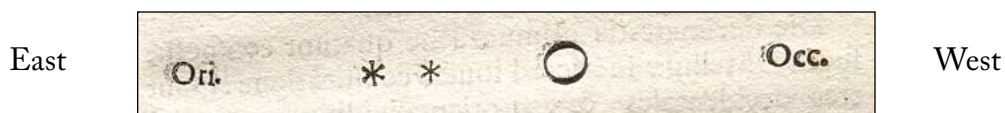
Then, on the tenth, the stars appeared in this position with regard to Jupiter. Only two stars were near him, both to the east.



The third, as I thought, was hidden behind Jupiter.<sup>73</sup> As before, they were in the same straight line with Jupiter and exactly aligned along the zodiac. When I saw this, and since I knew that such changes

could in no way be assigned to Jupiter, and since I knew, moreover, that the observed stars were always the same ones (for no others, either preceding or following Jupiter, were present along the zodiac for a great distance), now, moving from doubt to astonishment, I found that the observed change was not in Jupiter but in the said stars. And therefore I decided that henceforth they should be observed more accurately and diligently.

And so, on the eleventh, I saw the following arrangement:



There were only two stars on the east,<sup>74</sup> of which the middle one was three times as far from Jupiter than from the more eastern one, and the more eastern one was about twice as large as the other, although the previous night they had appeared about equal. I therefore arrived at the conclusion, entirely beyond doubt, that in the heavens there are three stars wandering around Jupiter like Venus and Mercury around the Sun. This was at length seen clear as day in many subsequent observations, and also that there are not only three, but four wandering stars making their revolutions about Jupiter. The following is an account of the changes in their positions, accurately determined from then on. I also measured the distances between them with the glass, by the procedure explained above. I have added the times of the observations, especially when more than one were made on the same night, for the revolutions of these planets are so swift that the hourly differences can often be perceived as well.

Thus, on the twelfth, at the first hour of the following night, I saw the stars arranged in this manner. The more eastern



star was larger than the western one, but both were very conspicuous and bright.<sup>75</sup> Both were 2 minutes<sup>76</sup> distant from Jupiter. In the third hour a third little star, not at all seen earlier, also began to appear. This almost touched Jupiter on the eastern side and was very small. All were in the same straight line and aligned along the ecliptic.

On the thirteenth, for the first time four little stars were seen by me in this formation with respect to Jupiter.<sup>77</sup> Three were on the west and one on the east. They formed a very nearly straight line,



but the middle star of the western ones was displaced a little to the north from the straight line. The more eastern one was 2 minutes distant from Jupiter; the intervals between the remaining ones and Jupiter were only 1 minute. All these stars displayed the same size, and although small they were nevertheless very brilliant and much brighter than fixed stars of the same size.

On the fourteenth, the weather was cloudy.

On the fifteenth, in the third hour of the night, the four stars were positioned with respect to Jupiter as shown in the next figure.



They were all to the west and arranged very nearly in a straight line, except that the third one from Jupiter

Many more pages of observations follow. You can sense some haste in Galileo's writing. He is almost uniquely passionate and observant, but he cannot know whether he has competitors making similar observations.

Note also that Galileo was born the same year as Shakespeare, 1564, but Shakespeare will die in 1616, aged only 52, and only 6 years after the *Starry Messenger* was published. Galileo will live until 1642.