

Page	Line	For	Read
449	+ 13	$\frac{1}{1047.819}$	$\frac{1}{1047.879}$
451	+ 6	$\frac{d^2 \delta x}{dt^2}, \frac{d^2 \delta y}{dt^2}, \frac{d^2 \delta z}{dt^2}$	$\omega^2 \frac{d^2 \delta x}{dt^2}, \omega^2 \frac{d^2 \delta y}{dt^2}, \omega^2 \frac{d^2 \delta z}{dt^2}$
451	+ 14	" " "	" " "
455	- 14	$t$	$t'$
455	- 8	$t$	$t'$
455	- 4	$z_r = z$	$z_r = z''$
485	- 4	$x_r$	$z_r$
485	- 3	$y_r$	$z_r$
487	- 3	$y d\beta$	$y \delta \beta$
492	+ 13	$\frac{d \delta M}{dt}$	$\frac{d \delta M}{dt}$
495	+ 16	$(\sin \Omega - h)$	$\sin (\Omega - h)$
503	+ 15	$\frac{d^2 \delta z_r}{dt}$	$\frac{d^2 \delta z_r}{dt^2}$
504	- 5	$\delta N$	$\delta N'$
515	+ 6	(192)	(193)
518	- 10	$\frac{2}{r^2} \left[ \frac{dr}{dt} \right]$	$-\frac{2}{r^2} \left[ \frac{dr}{dt} \right]$
519	- 6	$2 p r$	$2 r \sqrt{p}$
549	+ 11	direct action of the sun to its disturbing action	disturbing action of the sun to its direct action
649	- 10	$- 0''.00000272295 t$	$- 0''.00000272295 t^2$

Page 36.—The author's statements concerning the permanency of geographical positions should be modified, in view of the results of recent investigations of the latitude problem.

[NOTE.—I would esteem it a very great favor if the readers of this book would inform me of any errata which have escaped my notice].

ANN ARBOR, Mich., 1890, December.

THE FIREBALL IN RAPHAEL'S MADONNA DI FOLIGNO.

BY PROFESSOR H. A. NEWTON.\*

In a recent *Notice from the Lick Observatory*,† Director HOLDEN called attention to the fireball which RAPHAEL painted in his picture, the Madonna di Foligno. Any facts relating to such a representation in such a picture cannot fail to be of general interest.

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† Publications of the Astronomical Society of the Pacific, vol. ii, p. 19

Among the Italian pictures in the Yale School of Fine Arts is a copy of this painting by TERRY, and the copy is of such excellence that it has been hung in a prominent place in a collection consisting otherwise of original Italian works. In the picture the Virgin is in the clouds, and underneath the clouds is a landscape with buildings. Upon the face of the sky and landscape is a rainbow, so placed as to suggest that the clouds under the Virgin's feet were resting upon the bow. Under the bow is a fireball of a tolerably brilliant red color. It is rounded in front and tapers somewhat behind. Slightly separated from the ball is a long reddish cloud curving back across the sky along the path which the fireball has described. This ball and cloud have sometimes been taken for a bomb and its track. The likeness of the representation to the usual pictures of bright fireballs and their trains, and the want of likeness to a bomb and its train are manifest upon the most casual examination. I feel sure that RAPHAEL did not mean to depict a bombshell.

The introduction of a rainbow in a painting of the Madonna is not unique, and it may safely be assumed that its use is symbolic, and that the bow is not a mere ornament of the landscape. In fact, if this last purpose had been the ruling one, we ought to have had a more natural representation of the rainbow, at least one more natural than that given in the copy. Moreover, since the painter placed a fireball and its train in close connection with the bow, we are naturally led to ask what is the significance of such an unusual addition to the picture?

The picture was painted, it is said, in the year 1511 or 1512, for SIGISMONDO DEI CONTI DA FOLIGNO, private secretary of Pope JULIUS II. In the foreground is the figure of SIGISMONDO kneeling. SIGISMONDO died on the 18th of February, 1512. He had been made *Segretario domestico* to the Pope in 1503, and in his old age is said also to have been made prefect of the *reverenda fabbrica di San Pietro*, to which he bequeathed a considerable fortune. In this office he must have come into relations with RAPHAEL, after the latter came to Rome, in 1508, and shortly before his own death SIGISMONDO ordered the painting of the famous picture. Tradition says that it was made in fulfillment of a vow, but I am not aware of any historic basis for the tradition. It is not improbable that the fireball first suggested the idea that the picture was a votive offering. It is not unlikely, also, that the picture was actually painted after the death of the secretary.

On the 4th of September, 1511, in the second hour of the night,

there fell on the banks of the Adda, near Crema, some leagues southeast of Milan, a number of stones. The following are accounts of this fall:

1. From the manuscript diary of a shoemaker, GIOANNI ANDREA DA PRATO, who resided in Milan, AMORETTI\* quotes the following entry made contemporary with the stonefall. The manuscript was in the Ambrosian Library in Milan:

“Ma prima che avanti col calamo scorra, dirò siccome il giorno quattro di settembre a ore due di notte, e anche alle sette apparve in aere in Milano un tale splendore di corrente fuoco, che pareva refarsi il giorno; e da alcuni entro vi fu veduta una similitudine d’una grossa testa; il che diede alla città gran maraviglia e spavento; e il simile ancora accadette la notte seguente alle nove ore; poi dopo pochi giorni ultra il fiume Adda cascarono dal cielo molte prede (pietre) le quali raccolte furono nel Cremasco de libbre undici, e de libbre octo di colore simile a pietra arsa.”

2. BIGOT DE MOROGUES† quotes from Père BONAVENTURE DE SAINT-AMABLE ‡ this account:

“Le 4 septembre, 1511, à Crème, en Lombardie, pendant un orage épouvantable, il tomba dans la plaine des pierres d’une grosseur considérable: six de ces pierres pesoient cent livres. On en porta une à Milan, qui pesoient cent dix livres. Leur odeur étoit semblable à celle du soufre. Des oiseaux furent tués en l’air, des brebis dans les champs, et des poissons dans l’eau.”

3. CARDANUS, in a treatise, *De rerum varietate*,§ says:

“Vidimus anno MDX cum cecidissent e coelo lapides circiter MCC in agrum fluvio Abduæ conterminum, ex his unum CXX pondo, alium sexagita delati fuerunt ad reges Gallorum satrapas pro miraculo, plurimi; colos ferrugineus, durities eximia, odor sulphureus; praecesserat in coelo ignis ingens hora tertia; decidentium lapidum strepitus hora quinta exauditus. Ut mirum sit horis duabus tantam molem in aere sustineri potuisse. Intra viginti menses pulsi Galli. Triennio post reuersi, varia prius fortuna, inde iterum pulsi, ad excidium profligati. Urbs nostra in cujus finibus ceciderant lapides, vectigalibus, incendio, fame, obsidione, peste nunquam alias vexata grauius.”

\* Opusculi Sceltii t. 22, p. 261, note; see also, CHLADNI, Feuer-Meteore, Wien, 1819, p. 210.

† Mémoire historique et physique sur les chutes des Pierres, etc., Orléans, 1812. p. 66.

‡ Annales du Limousin, vol. iii, p. 746.

§ Reprinted in his works. See vol. iii, p. 278; Lyons, 1663.

4. LUBIENIETSKI\* quotes from KECKERMANN'S *Syst. Phys.*, 1.6, c. 5, p. 890, as follows:—

“1511. Suessanus Scaligeri praeceptor commemorat, anno 1511, in Lombardia cometam instar ignei pavonis per aëra volitasse, e quo, cum evanisset, tres lapides sulphurei deciderint, horum primus 160 libras, alter 60 libras, tertius 20 libras pondere aequavit.”

Several other accounts are quoted, or referred to, by CHLADNI, some of which are apparently repetitions of one or other of the above. CARDANUS wrote his account when he was well advanced in years, and the stonefall occurred when he was ten years old, and living at Pavia, near the place of fall. He is not a careful writer, and his story, instead of being treated as that of an eye-witness, should be looked at as the rehearsal of what CARDANUS had heard people say in his childhood. It well expresses the fears then so common which large meteors and comets caused to men, and the belief that they were omens of terrible significance. His date is evidently in error. We may well question nearly all the details of all the accounts, but that many stones fell and some were carried to Milan and other cities, can hardly be doubted. It is, so far as I know, the only detonating meteor falling in Italy during several years preceding 1512, of which an account has been preserved. I believe that RAPHAEL meant to represent this Crema aerolite in his painting of the Foligno Madonna.

What men thought of such phenomena was shown on the occasion of the fall of the Ensisheim stone nineteen years earlier. This fell near the lines separating the contending French and Imperial forces. MAXIMILIAN, soon after the fall, had the stone brought up to the castle, and he held a council of state to consider what the stonefall meant. SEBASTIAN BRANT, in a poem describing the fall, speaks of the terror it caused to the Burgundians and French. Eleven years later, that is, in 1503, MAXIMILIAN, in a proclamation appealing for aid against the Turks, includes the Ensisheim stonefall among other indications of divine favor. It is natural, therefore, to inquire whether the course of political events in Italy in the latter part of the year 1511 and the earlier part of 1512 were such as to give the Crema stonefall in the minds of men special significance.

In the summer of 1511 the French and their allies were waging war with the Pope and were in possession of Genoa, Ferrara, Milan, and the neighboring regions of Lombardy. They captured Bologna

\* *Theatrum Cometicum*, vol. ii, p. 320.

May 23, 1511. The Pope went to Rome June 27. In July he succeeded in forming a secret league with England, Spain and Venice to attack France. On the 17th of August the Pope was taken seriously ill, became unconscious on the 21st, and recovered consciousness on the 22d. On the 1st of September the schismatic council of Pisa was organized. The Crema stones fell into the French territory September 4th. The league between Spain, Venice and the Pope was published October 5th, and in November England, and subsequently MAXIMILIAN, joined the League. For a time success was with the French. On the 11th of April, 1512, the battle of Ravenna was lost by the papal forces and the Roman territory was seriously threatened. But, in spite of such temporary success, the French were forced to withdraw in June altogether from Milan and northern Italy. What would be more natural to RAPHAEL, under such circumstances, than to unite, in the altarpiece that he was painting, the fireball with the rainbow, in order to symbolize at once Divine reconciliation and assistance?

So far as I know no specimens of the Crema aerolites have been preserved. The accounts say nothing about the direction of motion of the fireball. It seems more probable, however, that the motion was from the south or west than from the north or east. The earth's quit was then about S.  $35^{\circ}$  W.,  $15^{\circ}$  or  $20^{\circ}$  high. I have elsewhere shown that aerolites in general follow the earth in its orbit, and this makes a motion of this stone from the S. or W. quite probable. If it was moving from the east of south it would be more strikingly visible in Rome, and its appearance in RAPHAEL's painting may be due to a brilliant course across the Roman skies.

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ON THE SIMILARITY OF CERTAIN ORBITS IN THE  
ZONE OF ASTEROIDS.

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BY Professor DANIEL KIRKWOOD, LL. D.

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[SECOND PAPER.]

In the *Publications* of the Astronomical Society of the Pacific, No. 7, March, 1890, the present writer named three pairs of minor planets whose orbits are characterized by remarkable similarity. Those given were selected from a larger number, so that only the most marked might first receive the attention of astronomers.