An Altmetric Analysis of Scholarly Publications from Earth and Planetary Science Discipline: An Exploratory Study of Indian Publications

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Abstract: *Since the inception of social media, entire human society has dramatically changed. Nowadays, social media has become an essential component of human society. Researchers or academicians are no exceptions. Social media has opened up new possibilities for researchers and academicians to evaluate scientific research based on social media data. In this response, altmetric is introduced as an emerging research area in scientometrics, where social media data is applied as source data for the evaluation of scientific research. The sufficient presence of altmetric data across scholarly publications is a prerequisite for developing new metrics in practice. This article aimed to investigate the presence of altmetric data in Indian scholarly publications compared to the world data. It has also explored the relationship among altmetric events (individual or aggregated) with citation scores. The result indicates that around 32.70% of Indian EPS articles are covered in social media, while 35.75% of research articles present at least one altmetric event for world data. The presence of altmetric events is still meager, except for Mendeley. A strong positive correlation is observed between citations and readership in Mendeley.*

Keywords: Social media metrics; Altmetrics; Earth and Planetary Science; Altmetric data coverage; Co-relational analysis; Altmetric presence; Social media attention.

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1. Introduction

The last few years have witnessed the unprecedented development of internet-aided tools, ICT, and more particularly, social media, which has changed the entire communication system of our society. In today's world, people use an extensive array of social media platforms to communicate with each other. The impact of social media is strongly felt not only on society, organizations, or businesses, but also transformed the entire process of scholarly practice, including access, storage, and dissemination of scholarly artifacts. This social media environment also opened up a new possibility and attracted wide attention from the researcher, publisher, and organizer in measuring the impact of scholarly articles. With the advent of the social web, scholars are gradually used to demonstrating their scholarly activities and live showcase of scientific information through various social media tools. It helped them quicker diffuse the brainchild of scientific knowledge and real-time interaction with their peers. When a piece of research is published in a journal, it's crucial to know how many people have read it, how many people have downloaded it, how many people have shared it on social media, and how other academics have reacted to it. However, social media has become very popular among the scientific community. In this context, altmetrics, a new indicator, has been proposed by Priem (Priem, 2010) and Priem & Hemminger (Priem & Hemminger, 2010) to measure scholarly activity on social media.

However, measuring scientific activity on the internet is not a new phenomenon. The birth of quantitative study about online activity and visibility of science arose in the 19th century with the introduction of webometrics, which measures the characteristics of the web quantitatively. These metrics have many limitations for research assessment as they can't reflect the broader impact of science. As a result, the term 'altmetrics' was proposed as an umbrella of online activity associated with various

social media platforms like Facebook, Twitter, blog, news, etc., and referencing platforms like BibSonomy, Mendeley, CiteULike, etc. It has been proposed as an immediate solution to two major problems for research assessment: accessing public engagement with research and time lags for obtaining citation counts (Thelwall, 2020). Beyond citations, the said metrics cover other aspects of research such as view, like, save, share, download, etc. Many researchers liked to prefer the term 'uses metrics' (Glänzel & Gorraiz, 2015) and 'informetrics or web-based social influence' (Rousseau & Ye, 2013) instead of altmetrics. Bornmann (2014) identified four advantages of altmetrics, namely, *broadness:* not only citations, but also other types of impact such as like, view, download, and share; *diversity:* beyond scholarly publications, it can measure all types of innovative or artistic work such as presentation, datasets, course materials, etc.; *speed:* it can overcome the time-related lacuna of citation counts i.e. time lags; *openness:* data can be access freely.

In this study, we consulted a large-scale dataset of 138,415 research articles (4,937 articles from the Indian share and 133,478 articles from the world share) covered by twelve narrow subject fields under Scopus's Earth and Planetary Science (EPS) discipline and corresponding altmetric data collected from altmetric.com. This study mainly focused on the presence of altmetric data in Indian publications, depending on narrow subject domains of Scopus's EPS discipline, compared to world share. In addition, we examine the relationship between altmetric events and citations for both datasets.

2. Related Literature

2.1 Coverage of Altmetrics

According to Bornmann[7], Altmetric is considered a hot topic in scientometrics because funding agencies and policymakers want to measure the broader impact of research, particularly public engagement with research (Piwowar, 2013). However, existing studies have been analyzed and it has been found that there are subsequent coverage differences across different altmetric events for scientific literature. Thelwall et al. (2013) conducted a study based on PubMed articles and examined the presence of altmetric data from 11 categories. They found that the presence of altmetric data for all categories was subsequently low, except for Twitter. In a similar large-scale study from altmetric.com, Costas et al. (2015) remarked the presence of five altmetric data for WoS articles: Facebook walls (16.4%), Blogs (12.5%), Twitter (88.01%), Google+ (4.0%), and News outlets (3.1%). Zahedi et al. (2014) analyzed a sample of 20,000 publications from WoS and Impact Story and reported the presence of four altmetric tools: Mendeley (62.6%), Twitter (1.6%), Wikipedia (1.4%), and Delicious (0.3%). They also concluded that review articles showed the largest presence, whereas other documents showed comparatively low values in terms of altmetric data.

There have also been many studies focusing on the disciplinary coverage of altmetric data. Hammarfelt (2014) conducted a survey based on humanities articles and found that Mendeley covered the highest, followed by Twitter, Blogs, etc. Similarly, Banshal et al. (2019b) reported that altmetric data varied by discipline. They found publications from Multidisciplinary and Medical Science fields that exhibited the highest coverage percentage in altmetric. Another study by Repiso et al. (2019) remarked on the coverage of altmetric data for communication journals and mentioned the most extensive coverage by Mendeley (98.85%), followed by Twitter (85.15%), Facebook (20.46%), Blog (11.08%), and News stories (9.23%).
A small number of articles mentioned the presence of altmetric data in Indian scholarly articles. A study was conducted by Banshal et al. (2018) based on 88,259 research articles originating from India as indexed by WoS during 2016, and corresponding altmetric data were collected from ResearchGate. Their finding showed that 61% of WoS research articles from India had been found in ResearchGate. Another large-scale study in the same line by Banshal et al. (2019a) found that 28.5% of research articles from India had at least one social media mention

2.2 Correlation between Altmetric Events and Citations

There are existing pieces of literature that show the correlation between citations and altmetric events. Thelwall et al. (2013) examined the relationship between 11 altmetric events and citations. They found positive correlation outcomes but insignificant for all altmetric events, except Twitter. Research highlights (RH) had registered with the largest value (0.373) among the 11 events. Costas et al. (2015) conducted a correlational study between citations and altmetrics from a multidisciplinary perspective. The results showed a positive correlation but were relatively weak. They concluded that altmetrics events could not reflect the same scholarly impact for research articles as citations. A meta-analysis had conducted by Bornmann (2015) based on co-relational studies among citations and the three most important and prominently used altmetric events: micro-blogging tool (Twitter), online referencing tools (CiteULike and Mendeley), blogging tool. This study found positive negligible correlation for micro-blogging counts (r=0.003), small for blog counts (r=0.12), and medium to large correlations for online referencing tools (CiteULike; r= 0.23, Mendeley; r= 0.51). Ouchi et al. (2019) analyzed a sample of 1,000 highly-cited research articles from Nature and established the relationship between altmetrics and citation counts. The results showed significant positive correlations between the said variables, ranging from 0.160 (News Stories) to 0.724 (Mendeley Readers).

Some previous studies showed correlation analysis among altmetric events and citations counts based on research articles from India which are: Lamba et al. (2021) conducted a cohort analysis based on 669 computer science research articles from 35 central universities of India and established the relationship between altmetric score and citations using co relational study. Their results showed almost positive correlations among altmetric events and citation counts, but these

correlation results are relatively low, except for Mendeley readers. Banshal et al. (2021) examined large-scale Indian research articles as indexed in the WoS database and corresponding altmetric mentions from ResearchGate and three altmetric events (Facebook, Twitter, and Blogs) for 2016. The results showed weak positive correlations, but the values were relatively strong when they consulted ResearchGate data. They also found some disciplinary variations in the magnitude of correlations.

The existing body of literature analyzed altmetric data for a sample dataset. It established the relationships among individual altmetric events, such as CiteULike or Mendeley readers, Twitter, Facebook, Blogs, Google+ predominantly, and citation counts. However, none of the research reported the altmetric presence of articles from Scopus's narrow subject fields. In this paper, we aimed to fulfill this research gap and analyze Indian EPS research articles compared to world share and establish the relationship between altmetric scores and citation scores in the narrow subject domains of EPS discipline.

4. Research Questions

The main goal of this research paper is to measure the coverage and presence of altmetric data among scholarly publications from India, in comparison with the world share, in the field of Scopus's Earth and Planetary Science (EPS). In addition, the study has also examined the relationship between altmetric events (aggregated and individual) and citation counts. Thus, in this regard, we formulated specific research questions, which are:

RQ1: To what extent Indian EPS research articles are covered and mentioned in altmetric events?

RQ2: In altmetric mentions, are Indian articles larger/smaller than world share?

RQ3: Do altmetric events (aggregated or individual) positively/significantly correlate with citation counts? Which social media platforms correlate well with citation counts?

RQ4: Which social media tools are frequently used by researchers/academicians?

RQ5: Are there any discipline-wise variations that exist in altmetric data? Which discipline gets the most significant presence in altmetric data?

5. Data and Methods

All bibliographic data related to the Earth and Planetary Science (EPS) articles were collected from the Scopus database and altmetric data from altmetric.com. This database was selected because of its extensive coverage of scientific journals (Mongeon & Paul-Hus, 2016). All articles were downloaded for the year 2017. The year was selected to give minimum time to accumulate citations (Sud & Thelwall, 2014). We used Scopus All Science Journal Classification (ASJC) codes[1]. There were 14 little fields found within the earth and planetary science category. Whereas two fields, namely General Earth and Planetary Sciences and Earth and Planetary Sciences (miscellaneous), were excluded because these do not represent any specialized research areas. Finally, 12 narrow fields were included in this study, i.e., Atmospheric Science (ASC), Computer in Earth Science (CES), Earth-Surface Processes (ESP), Economic Geology (EGY), Geochemistry and Petrology (GCP), Geology (GLY), Geophysics (GPS), Geotechnical Engineering & Engineering Geology (GEG), Oceanography (OGY), Paleontology (PGY), Space and Planetary Science (SPS), and Stratigraphy (SGY). A code number represents every research area. For instance, 1902 is for Atmospheric Science, 1903 is for Computers in Earth Science, etc. The bibliographic information of articles was downloaded as of September 2020, and the search string was formulated using ASJC code as follows:

SUBJMAIN (1902) AND DOCTYPE (ar) AND SRCTYPE (j) AND (LIMIT-TO (PUBYEAR , 2017)) AND (LIMIT-TO (AFFICOUNTRY, INDIA))

A total of 4,937 Indian articles with at least one Indian affiliation were found for 2017. Since unique identifiers are required for gathering altmetric data, only articles with DOI were considered in this study. Among these 4,937 articles, 4,447 (90.07%) articles were found with DOI. Each dataset was downloaded using standard metadata like authors, title, year, source title, DOI, Scopus ID, etc. To compare with World share, we also downloaded corresponding data for the whole world. A total of 133,478 articles were downloaded for World share. Among these, 127,530 (93.54%) articles were found with DOI. Corresponding altmetric data were collected from altmetric.com API using Webometric Analyst software. This database was chosen because it is the most comprehensive data source for social media counts of scholarly articles[23]. This database provides altmetric data regarding Altmetric Attention Score (ASS), Mendeley Readers (MR), Blog mentions (BM), News mentions (NM), Twitter mentions (TM), Redditers mentions (RM), Facebook mentions (FM), Wikipedia mentions (WM), Reviews

[1] https://www.elsevier.com/solutions/scopus/how-scopus-works/content

and Highlights (R&H), Questions & Answers (Q&A), and Google Plus (GP). The data were collected during December 2020. The Spearman correlations were performed with R programs to express the associations between citations and altmetric events at the disciplinary level.

6. Results and Discussion

The computational analysis of data produced the analytical results for altmetric events of EPS research articles. This part consists of three sections: firstly, the overall coverage level of altmetric data for EPS articles from India and its comparison with the global share. The second section focuses on disciplinary coverage. The third section compares the associations between altmetric events and citations.

6.1 Overall Coverage

The first computational results show the overall presence of altmetric of EPS research articles from India. Out of the total, 4,447 EPS articles from India as indexed in Scopus were found with DOI, only 1,454 articles were found with at least one altmetric mention, and 3962 articles were found with Mendeley readers. The presence of altmetric varies greatly by different social media tools like Mendeley, Twitter, Blog, News, etc. Table 1 presents the altmetric coverage of EPS scholarly articles from India. Compared to the other altmetric events, Mendeleyreadership (MR) has the most extensive coverage (89.09%). Altmetric Attention Score (AAS) holds the second position with coverage of 32.70% of EPS articles, followed by many mainstream and social media platforms like Twitter mentions (TM), Blog mentions (BM), and Facebook mentions (FM), News mentions (NM), etc. Twitter has featured around 28% of EPS articles, 7.24% of articles by Blog, and 6.10% of articles by Facebook. Among these altmetric events, News mentions occupied 2.16% of articles, but the MPA value is recorded as the second largest, after MR. It indicates some Indian articles have more impact on society as posted many times in News Outlets.

Table 1. Overall social media coverage of EPS articles

	India				World			
Categories Mention	Total Publications	%	Total Mentions	MPA	Total Publications	%	Total Mentions	MPA
ASS	1454	32.70	13087	9.00	45589	35.75	488938	10.72
MR	3962	89.09	82842	20.91	108202	84.85	2064459	19.08
BM	322	7.24	405	1.26	9852	7.73	14309	1.45
NM	96	2.16	927	9.66	4711	3.69	31477	6.68
TM	1245	28.00	5093	4.09	38915	30.51	217990	5.60
RM	7	0.16	8	1.14	311	0.24	382	1.23
FM	271	6.10	384	1.42	9884	7.75	13868	1.40
WM	67	1.51	89	1.33	2787	2.19	4399	1.58
R&H	9	0.20	12	1.33	28	0.02	36	1.29
Q&A	8	0.18	10	1.25	24	0.02	31	1.29
GP	63	1.42	131	2.08	1546	1.21	4033	2.61

MPA = Mention Per Article

To compare with the world share, all research articles from EPS subject domain for the corresponding year were downloaded from the Scopus database. Out of the total, 127,530 articles had found with DOI. Among these, 45,589 articles have been found with at least one altmetric event and 108,202 articles with Mendeley readership. The highest inclusion of articles has been covered by Mendeley, which was 84.85% of total publications (Table 1). ASS has the second largest presence of 35.75%, followed by TM with 30.51%, FM with 7.75%, BM with 7.73%. The presence of remaining altmetric events is deficient. The NM, WM, and GP covered only 3.69%, 2.19%, and 1.21% of total articles.

In comparison, the presence of altmetric events was less than 1% for R&H and Q&A. Thus; this study reveals that, in general, in some platforms, Indian articles are getting lower atlmetric mentions than the world share. But some social media tools like R&H, Q&A, and GP are getting higher altmetric mentions for Indian articles. And the mentioned difference lies between 0-2% for India's and the world's scholarly articles on different platforms.

6.2 Disciplinary Coverage

Table 2 presents the coverage of altmetric data from Indian EPS articles in six altmetric events, such as ASS, MR, BM, NM, TM, and FM. In general, Indian research articles from the Medical Science domain received the highest altmetric attention (Banshal et al., 2019a; Nath et al., 2020), but our study based on the narrow subject domain shows another picture, some disciplines are showing different patterns of coverage in various social media platforms. For instance, in ASS, the highest coverage of attention was received by SPS, with a value of 59.98%, followed by OGY, ASC, and PGY with coverage of 46.39%, 41.04%, and 38.73%, respectively, and GEG, SGY has the lowest value of 7.27%, 17.65%, respectively. In MR, the CES has the highest presence, accounting for 92.79%, followed by EGY with 92.31%, ASC with 91.79%, and GPS with 90.91%. The SPS, GLY, and GEG have recorded with most diminutive presence in MR, accounting for 86.74%, 86.92%, and 87.62%, respectively.

Table 2. Disciplinary coverage of EPS articles from India

		No. of articles (%)					
Disciplines	No. of Articles	ASS	MR	BM	NM	TM	FM
ASC	597	245 (41.04)	548(91.79)	28(4.69)	17(2.85)	214(35.85)	56(9.38)
CES	131	28 (21.37)	121(92.37)	1(0.76)	1(0.76)	22(16.79)	4(3.05)
EGY	52	12 (23.08)	48(92.31)	1(1.92)	0(0.00)	11(21.15)	1(1.92)
ESP	427	131 (30.68)	383(89.70)	11(2.58)	5(1.17)	115(26.93)	18(4.22)
GCP	380	65 (17.11)	345(90.79)	5(1.32)	3(0.79)	60(15.79)	13(3.42)
GLY	612	131 (21.41)	532(86.92)	9(1.47)	4(0.65)	112(18.30)	10(1.63)
GPS	407	95 (23.34)	370(90.91)	15(3.69)	6(1.47)	90(22.11)	19(4.67)
GEG	509	37 (7.27)	446(87.62)	2(0.39)	1(0.20)	26(5.11)	5(0.98)
OGY	319	148 (46.39)	289(90.60)	14(4.39)	4(1.25)	140(43.89)	19(5.96)
PGY	142	55 (38.73)	126(88.73)	6(4.23)	2(1.41)	49(34.51)	13(9.15)
SPS	837	502 (59.98)	726(86.74)	228(27.24)	54(6.45)	401(47.91)	111(13.26)
SGY	34	6 (17.65)	30(88.24)	1(2.94)	0(0.00)	5(14.71)	2(5.88)

Table 3 represents similar results for the world publications data. The SPS, PGY, and ASC have the most extensive coverage on ASS, accounting for 64.03%, 58.60%, and 51.41%, respectively. OGY and GEG have the most negligible presence on ASS, accounting for 7.17% and 8.20%. We observed that the SPS discipline had shown a considerably highest coverage of all altmetric events (ASS, BM, NM, TM, FM) over other fields, except for MR. In MR, the most increased presence of altmetric data comes from ASC (91.6%), followed by CES (90.57%), OGY (89.91%), and GPS (87.26%). Moreover, the presence of altmetric data in scholarly publications is highly skewed. The majority of research articles receive very few altmetric mentions. While comparing with Indian articles, world data gets a higher presence in altmetric events, but it depends on mentions type. In terms of ASS, the magnitude of coverage overall varies from 5% to 12% over disciplines.

6.3 Relationship between Altmetric events and Citations

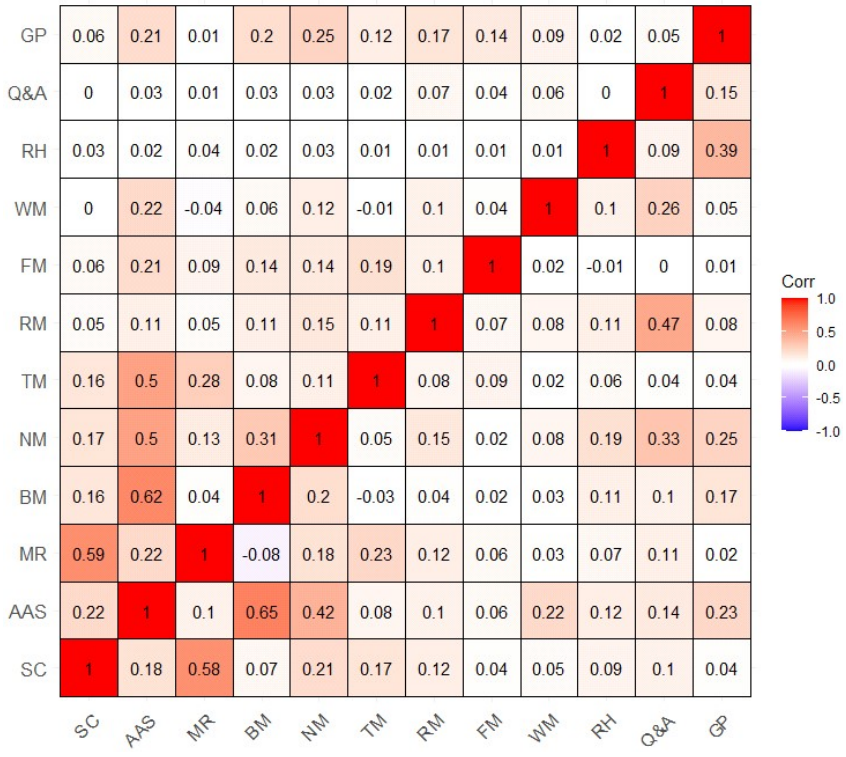
To measure the association between citations and altmetric events, Spearman correlation was performed for both datasets, i.e., India and the world. The correlation results were interpreted using the scale given by Akoglu (2018). The correlogram in Fig. 1 depicts the correlation values and the relationship among citation scores and altmetric events for India's (top-left triangle) scholarly articles and the world's (bottom-right triangle) scholarly articles. The higher correlation indicates a similar presence of altmetric data between two variables, whereas those with weak correlation represent different presence patterns of two variables. Mendeley readership is the only altmetric event that is positively strongly correlated with citation scores for

Table 3. Disciplinary coverage of EPS articles from the world

		No. of Articles (%)					
Disciplines	No. of articles	ASS	MR	BM	NM	TM	FM
ASC	13,852	7121(51.41)	12689(91.60)	1123(8.11)	665(4.80)	6594(47.60)	1644(11.87)
CES	2,948	943(31.99)	2670(90.57)	37(1.26)	52(1.76)	849(28.80)	189(6.41)
EGY	2,639	288(10.91)	2040(77.30)	15(0.57)	14(0.53)	240(9.09)	22(0.83)
EPS	12,200	5082(41.66)	10370(85.00)	673(5.52)	375(3.07)	4605(37.75)	1079(8.84)
GCP	14,468	4148(28.67)	11624(80.34)	629(4.35)	417(2.88)	3593(24.83)	938(6.48)
GLY	15,838	3562(22.49)	12534(79.14)	243(1.53)	297(1.88)	3017(19.05)	633(4.00)
GPS	13,321	5331(40.02)	11624(87.26)	1016(7.63)	669(5.02)	4748(35.64)	1279(9.60)
GEG	14,203	1164(8.20)	11631(81.89)	65(0.46)	66(0.46)	947(6.67)	254(1.79)
OGY	11,493	824(7.17)	10333(89.91)	101(0.88)	63(0.55)	742(6.46)	186(1.62)
PGY	5,809	3404(58.60)	4829(83.13)	558(9.61)	331(5.70)	2890(49.75)	916(15.77)
SPS	19,065	12207(64.03)	16019(84.02)	5344(28.03)	1746(9.16)	10295(54.00)	2644(13.87)
SGY	1,694	480(28.34)	1466(86.54)	53(3.13)	22(1.30)	399(23.55)	115(6.79)

both datasets, i.e., India's data and the world's data—being the same line with the existing conclusions by Eldakar (2019) and Mohammadi et al. (2015) about the strong positive correlation among the said pair of data at the discipline.level.

Figure 1. Spearman correlations of India's (upper-left triangle) and World's (bottom-right triangle) scholarly articles among citation scores and altemetric events (individual and aggregated). Scopus Citation (SC), Altmetric Attention Score (ASS), Mendeley Reader (MR), Blog mentions (BM), News mentions (NM), Twitter mentions (TM), Reddit mentions (RM), Facebook mentions (FM), Wikipedia mentions (WM), Review and Highlights (RH), Questions and answers (Q&A), Google plus (GP).



Although the lens of Indian scholarly articles, altmetric attention score is strongly correlated with blog mentions, news mentions, and Twitter mentions. It indicates similar distribution patterns of altmetric data for the said variables. Strong correlations are observed for the world data for altmetric attention score with blog mentions and news mentions. Amongst the altmetric events, moderate correlations are observed between research and highlights vs. google plus; news mentions vs. questions and answers. We observed most altmetric events are weakly correlated with citations across two datasets. A likely reason is different distribution patterns of citations and altmetric data.

7. Conclusion

In this study, we investigated the presence of 11 altmetric events for many scholarly articles as indexed in Scopus across 12 narrow subject fields of the Earth and Planetary Science discipline. We established the relationships between altmetric events and citations. Amongst the ten individual altmetric events, Mendeley readers (MR) and Twitter mentions (TM) have the most significant presence in altmetric, but the presence of remaining events is still relatively low. However, altmetric mentions are biased to newly published research publications, while older publications get fewer mentions. We observed some disciplines with higher altmetric mentions, such as ASS, SPS, and PGY, on the other hand, some disciplines with lower altmetric presence (GEG).

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