Expanding Perspectives on Open Science: Communities, Cultures and Diversity in Concepts and Practices
L. Chan and F. Loizides (Eds.)
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Arxiv-Based Commenting Resources By and For Astrophysicists and Physicists: An Initial Survey

Monica MARRA[1]
INAF – Osservatorio Astronomico di Bologna

Abstract. This paper results to be the first, though absolutely initial, overview of commenting platforms and other web 2.0 resources which were born for and within the astrophysical research community, from 2004 to 2016. Additional experiences, chiefly in the physics domain, were added for a total of twenty-one tools, inclusive of four items in the specific area of epijournals – plus four supplementary resources which have been simply mentioned or anyway much more synthetically described due to their specific features –, thus casting some light onto an unexpected richness and consonance of endeavours. These experiences rest on the contents of the pioneering database ArXiv, which adds to its universally recognized merits that of setting the grounds for web 2.0 resources, and research behaviours, to be put in place. These resources were surveyed substantially through the method of empirical evidence, partly routed by the web resources examined and by some of the literature, and are accounted for in a time sequence for their essential features. Most of the experiences retrieved are UK- and US-based, but other countries have been involved, such as Italy, the Netherlands and China. Final remarks are sketched. The results integrate the previous studies according to which the web 2.0 is presently of limited use for scholarly communication within the astrophysical community. Collaterally, some aspects of ArXiv's recent pathway towards partial inclusion of web 2.0 features are touched upon. The centrality of the scholarly literature for web 2.0 interactivity in astrophysics and – more presumably – in some other branches of the physics domain emerges as a plausible hypothesis and as a promising research suggestion. Further investigation is not only needed, but also absolutely hoped for.

Keywords. open commenting, open science, web 2.0, ArXiv, astrophysics.

1. Methodology

The research that follows can be estimated to have required about thirteen months of activity (FTE); it was partly conducted alongside with the preparation work for different projects. The first documentation (both literature and web resources) was retrieved in late 2014, the last one in March 2017.

Search engines have proved to be of limited usefulness in order to let these resources come to light. Queries have been executed with the phrases: 1) "arxiv comment*", 2) "arxiv discuss*", 3) "arxiv peer review*". The first three pages of results (30 items) for these queries yielded a total of five of the items here presented,

[1] Monica Marra, INAF-Osservatorio Astronomico di Bologna, Via Gobetti 93/3, I – 40129 Bologna, Italy; E-mail: monica.marra@oabo.inaf.it.

meaning that only 23.8% of the twenty-one main resources here described were retrieved directly through the search engine.

Other important sources for the present findings have been previous online compilations, such as the wide shared database *400+ Tools and innovations in scholarly communication* ([1], last visited March 20, 2017), first published in March 2015 by Bianca Kramer and Jeroen Bosman of Utrecht University Library and then constantly updated. As at March 21, 2017, it lists as many as 668 resources. This unique collection has been thoroughly consulted in spring 2016, with subsequent inspections later in 2016 and in 2017. At the moment of writing, it contains seven of the resources in the present survey (33.3% of the main group), only one of which - *ViXra* - can be retrieved also through the search engine above, plus *Discrete analysis* among the simply mentioned ones. The utility of this resource has been concrete and unquestionable; anyway, due both to the continuous update of the database and to the prolonged and multiple-source documentation activity which has brought to the present results, it would be difficult to reconstruct exactly, and retrospectively, the percentage of *400+ tools* which represented an actual source for our findings.

Also very important in order to build up the present survey were (social) media mentions, with special referral to blog comments suggesting resources. In fact, tracking comments on appropriated blog threads for as much as it has been possible, as well as practising web browsing to some extent starting from the resources already retrieved, have proved to be fruitful strategies for getting to the present findings. Actually, it can be realistically estimated that they made it possible to retrieve eleven out of the twenty-one resources in the main list (52.38%), plus one of those simply mentioned. A colloquium with an astrophysicist was the original source for a further platform, *Cosmocoffee*.

Precious details about some of the projects surveyed came from email exchanges with some of the researchers involved, as will be detailed below.

The majority of the bibliographic references was found in 2016 (~61%), with a further 31.7% being filed between 2013 and 2015. In fact, though, the literature was more useful for giving a profile to some of the themes involved than for providing concrete examples that be useful to the building of this survey. In fact, the literature was the original source for only two of the resources retrieved (*Naboj* and *The RIOJA Project*) – which doesn't mean that some more of these resources haven't received attention by researchers, journalists or bloggers, as indicated in the reference list.

The criteria for selecting the resources in this survey were: (a) having been created by researchers, (b) for their same scholarly communities, and (c) relying on ArXiv contents entirely or almost entirely.

2. The Importance of Arxiv Beyond Preprints Provision

The creation of ArXiv, the first and foremost preprint server in 1991, has been recognized as "the most significant change in scientific communication since the establishment of the journal in the 17th century" [2]. The importance of this novel way of circulating scientific papers much exceeds that of enhancing papers' availability in a peculiarly early stage of their customary disclosure. In fact, Arxiv has pioneeringly explored all the main changes in XX and early XXI century's scholarly communication practices – among which the progressive diffusion of the open access movement. The latter found ArXiv giving researchers the opportunity to upload accepted or published

versions of papers, thus putting those principles into practice for the communities involved, while the massive hosting of preprint papers let ArXiv be perceived as an implemented source for open contents, in spite of the conceptually specific nature of this task.

In fact, ArXiv's fruitfulness went beyond. As early as in 1994 - two years before it's often stated to have happened - Paul Ginsparg envisioned the possibility for ArXiv to act as a starting platform for add-on tools fostering not only dissemination but also validation practices, the latter through the birth of a network-based scholarly interactivity centered on ArXiv papers ([3], [4]). The classic article by Rodriguez *et al*. [5] shows how cleverly these suggestions could be seized just after the landmarking debut of the web 2.0 around 2005 [6]. At the same time, traditional peer-review's features and role in the science production chain were increasingly questioned ([7], [8]; a review is in [9]), while the milestone phenomenon of web 2.0 slowly began transforming academic practices – as acknowledged even in cautious scholarly perspectives ([10]). Useful studies have aimed at tracking the process and at casting light on a variety of 2.0 tools for the scholarly communities, as well as on patterns of their use ([11], [12], [13], [14], [1], [15]).

The role of ArXiv within this global, substantial paradigm change doesn't result to have been fully investigated yet. Also, to the best of our knowledge there aren't any comprehensive studies about how the web 2.0 attitude has progressively affected the astrophysical field, although some particular aspects were conveyed. Polydoratou and Moyle [16] have interestingly surveyed astrophysicists' attitudes towards ArXiv overlay journals in 2007, in the context of a specific project that will be accounted for *infra*. Valuable observations based on narrative interviews on this community's attitudes about communication and publication practices have been made by Harley *et al.* [17]. These authors maintain that "astrophysicists have limited engagement with Web 2.0 technologies". They also highlight the role of "email networks" for communication, and stress that "face-to-face interaction remains an essential part of the collaborative process", which has later been confirmed by Marra [18] in a specific context, and by Delfanti [19] for high energy physicists.

The use of Twitter among astrophysicists has received considerable attention in more recent years ([20], [21], [22]); the conclusions seem anyway to downplay its role for internal scholarly communication, although from the present point of view it has been interestingly noted that "most tweets refer to the ArXiv instead of the publishers' versions" [21] .

Ritson [23] has examined socio-scientific aspects of the "trackback system" connecting ArXiv papers and scientists' blogs since 2005, with an account of the science-and-technology-studies (STS) literature on the subject. From the present perspective, three points result to be fruitful: a) blogs, although peculiar in type, may well be considered means for providing papers with scientific feedback, included peer-review; b) in 2006, one year after the debut of the trackback system, blogs ArXiv had approved for trackback were 51 and trackbacks were 5132. If considered that (c) the high-energy physics community has long been discussing in order to find consensus on how to practically identify members enabled to have their blogs trackbacked to the ArXiv, these numbers cast light on a phenomenon that may well be considered potentially wider and significant.

Within the scientific communities, the topic of providing ArXiv with commenting or even peer-review-type capacities – or not – has long been debated, as researchers' blogs and forums can witness. An almost randomatic sampling – including the threads

https://www.physicsforums.com/threads/a-peer-review-system-for-the-arxiv.568276/ (2012; last visited March 8, 2017) and http://academia.stackexchange.com/questions/32367/why-doesnt-arxiv-have-a comment-section (2014, last visited March 8, 2017) – can provide an interesting insight into the views of shrewd and lively scientific communities.

2.1. Arxiv and Its Present Situation With Respect to the Web 2.0 Setting

It may appear somehow paradoxical that ArXiv, whose creator had so impressingly timely envisioned his database's web 2.0 potential, hasn't been equipped with tools for the new web ecosystem so far - notwithstanding ArXiv's persisting role as a pillar resource for astrophysicists. Paul Ginsparg's explanation for this slow pace has been the database's organizational framework due to budget and personnel constraints [24]. In fact, things seem now to be changing to some extent, as in April 2016 ArXiv conducted an online survey among its users in order to "improve arXiv and think of future directions for the service" [25]. One of the questions was aimed at measuring users' perception of importance for possible new services, among which the addition of a rating system for recommending papers and an annotation feature allowing commenting. The inclusion of these question looks meaningful and the subsequent development of a "next-generation arXiv" project in the next three years [26], although still not detailed, may let interested people envisage a renewed approach to these themes in the medium term.

As for now, the situation of ArXiv, jointly with its persisting overall popularity confirmed by the 2016 survey - 52.92% "very satisfied"; 42.43% "satisfied" – could bring to the supposition that the present, limited web 2.0 evolution of the database goes well with the astrophysical community's still prevailing inclination to tendentially preserve its scholarly practices.

In fact, there is significant evidence of commenting practices to ArXiv papers much beyond these traditional channels, with proper involvement of the web 2.0 setting.

3. Commenting on ArXiv

A largely practised mode of online interaction is represented by researchers' blogs and forums, which may comment on ArXiv papers. This specific channel is being barely mentioned here as the complexity of the scenario and the relations with ArXiv through the so-called "trackback system" [23] would require a dedicated and very extended analysis. A single experience will anyway be accounted for and it's the one of the astrophysical forum *Cosmocoffee* (http://cosmocoffee.info/, last visited March 1, 2017), born in September 2004, which had 2769 registered users as at March 1, 2017 (http://cosmocoffee.info/index.php, last visited March 1, 2017). Although in fact it results to be a multi-purpose information resource as it includes different-type information such as (but not limited to) conference announcements, job vacancies, discussions on three specific topics (e.g. "cosmological model"), founders "hope that it can also become a useful reference resource, complementing the arxiv itself" (http://cosmocoffee.info/faq.php#0, last visited March 1, 2017). "Daily we discuss work and new papers with colleagues, either at our local coffee break or via email with colleagues all over the world. This discussion can be an extremely effective way to

understand things better. As such, it seemed to make sense that those discussions be shared with others and be public. [...] Therefore we set up cosmocoffee.info as an attempt to facilitate this. The forum "is intended for authorised arxiv authors and students" (http://cosmocoffee.info/faq.php#0, last visited March 1, 2017). Posts can be read by both registered and unregistered users, but posting is only for the formers. Within *Cosmocoffee*, the sub-forum "ArXiv papers" appears to have started with a post by UK cosmologist Antony Lewis on September 24, 2004. This section has received a total of 1031 posts on 260 topics ((http://cosmocoffee.info/index.php, last visited March 1, 2017), with present last post dated August 15, 2014 (as at March 1, 2017); other sections (especially "computers and software", "job vacancies", conferences and meetings") are still current. Cosmocoffee's administrators result to be Sarah Bridle (University of Manchester), Olivier Dore (JPL-CalTech), Antony Lewis (University of Sussex) and Mike Nolta (Canadian Institute for Theoretical Astrophysics) (http://cosmocoffee.info/faq.php#0, last visited March 1, 2017; http://cosmocoffee.info/memberlist.php for (present) affiliations, last visited March 1, 2017). For as much as it results, *Cosmocoffee* has never been object of dedicated studies.

The present survey will focus on different-type resources which offer commenting features in the astrophysical and physical fields.

For presentation purposes, it seems possible to roughly divide them into three main categories:

a) resources or projects aimed at buiding new, open access and more interactive forms of the traditional scholarly journals. The model is that of the "overlay journal" or "epijournal" ([27], [28], [29]);
b) ArXiv-based commenting platforms. In some cases, they may be aimed at practical purposes such as selecting papers for "real life" scholarly discussions;
c) different tools which can very roughly be defined as variant forms of ArXiv – with whom they have no kind of affiliation or other apparent link. They will be conveyed firstly, due to their peculiar characteristics. The tools in this section generally have more limited web 2.0 capacities and are considerably different both from each other and partly from ArXiv, too. They witness a widespread effort to build upon the model, as well as ArXiv's totemic standing within the physics and astrophysics environments – e.g. in the names and graphic look of the first two tools in the list.

3.1. "Variant" Forms of ArXiv (3.c.)

The definition, as said before, is intentionally very broad and pragmatic, in order to group together online entities with a commenting feature appearing to be secondary compared to changes in some of ArXiv's main features (either improved search functions, or renewed visualization features of the original database, or adaptation to a different audience, or changes in authors' admission policy).

- **3.c.1.** *ViXra* (2009; http://vixra.org/, last visited March 17, 2017), created by the independent UK-based physicist Philip Gibbs, "has been founded by scientists who find they are unable to submit their articles to arXiv.org because of Cornell University's policy of endorsements and moderation [...]. ViXra is an open repository for new scientific articles. It does not endorse e-prints accepted on its website, neither does it review them against criteria such

as correctness or author's credentials" (http://vixra.org/, visited March 17, 2017).. Its aim is "to enable anyone to distribute their works of science and mathematics irrespective of their status or affiliations" (http://vixra.org/faq, visited February 2, 2017). As at February 2, 2017 it contained 17632 outputs, 1093 of which in astrophysics (http://vixra.org/). Some information about *ViXra* is in [30] and [31]; the tool is listed in [1].

- **3.c.2.** *SnarXiv* (http://snarxiv.org/, last visited March 17, 2017) was born in 2010 by initiative of David Simmons-Duffin, by that time a PhD student in high-energy physics at Harvard University, and in a somehow bohemian spirit. "The snarXiv is a random high-energy theory paper generator" (http://davidsd.org/ 2010/03/the-snarxiv, visited February 2, 2017). It contains an interactive game: "arXiv vs. snarXiv" (http://snarxiv.org/vs-arxiv/), where players have to spot genuine ArXiv titles from *SnarXiv* ones.
- **3.c.3.** *Astrobites* (https://astrobites.org/, last visited March 20, 2017) is a successful project created in 2010 by and for undergraduate students in astrophysics (https://astrobites.org/about/, last visited March 20, 2017). Its "goal is to present one interesting paper per day in a brief format that is accessible to undergraduate students in the physical sciences who are interested in active research" (*ibid.*) – although in fact it's also a web portal for different –type information. Typically, the papers suggested are from ArXiv's astrophysics section "astro-ph". The resource is written by "a team of graduate students at universities around the world" (*ibid.*) – but apparently mainly based in the US and in the UK (https://astrobites.org/2017/01/03/astrobites-a-look-back-at-2016/, last visited March 20, 2017) – which reached thirty members as at January 3, 2017. Past web hosting was at Harvard University, with the help of James Guillochon (https://astrobites.org/about/); remarkably, "since 2016 Astrobites has been hosted and supported by the American Astronomical Society". Links to other 2.0 resources here included are provided (*VoxCharta*, *ArXiver*); Astrobites has an account on Twitter (@astrobites), and another one on Facebook (https://www.facebook.com/astrobites/) with more than 5500 and more than 3700 followers respectively.
- **3.c.4.** 2013 saw the debut of *PaperScape* (http://paperscape.org/, last visited March 17, 2017), "an interactive map that visualises the arXiv" according to number and typology of the citations received. As one of the authors explains, it "visualises the entire arXiv database as a map that can be explored by panning and zooming. The papers are sized according to their number of citations and positioned according to their references/citations. Different categories of the arXiv are assigned different colours, and newer papers are more brightly coloured. The original project complements this map by letting you draw graphs of the papers that interest you, with the papers as nodes and citations as links. It's possible to register a personal profile, with which you can tag relevant papers as well as save and share the graphs you make" [32]. Developers are young physicists Damien P. George, currently at the Department of Applied Mathematics of the University of Cambridge, and Robert J. Knegjens. [1] includes it.
- **3.c.5.** Late 2013 saw the debut of *arXiver* (initially https://arxiver. wordpress.com/, then http://arxiver.net/, last visited February 14, 2017), whose "original credit for the idea" is acknowledged to the young British

astrophysicist and web 2.0 activist Robert Simpson (http://www.arxiver.net/about/, visited February 14, 2017); the resource is (co-)maintained by Australian postgraduate student Vanessa Moss. The first post available is dated October 8, 2013, (https://arxiver.wordpress.com/2013/10/08/, visited February 14, 2017). While staying updated with the literature through ArXiv is said to be highly appreciated, it is also maintained that this database is presently "not very nice to look at (too much text!)" and "it would be nice to be able to glance at a visually-appealing summary of different papers to then go forth and read properly" (https://arxiver.wordpress.com/about/, visited February 14, 2017); this seems to basically consist in providing meaningful, selected pictures from the article by the side of the ArXiv abstract. In fact, readers can also assign "likes" to papers' posts, but for as much as it's possible to see this has scarcely ever happened. An interesting feature was the initial absence of author names in new papers' posts, in order to correct for any possible author bias (later on, authors' names have been included up to the first three authors; https://arxiver.wordpress.com/faq/, visited February 14, 2017). Since its debut, *ArXiver* was equipped with a Twitter feed, @arXiver, which has 727 followers as at February 14, 2017.

- **3.c.6.** *Cloudy Science* (https://cloudyscience.wordpress.com/, last visited February 14, 2017) was born presumably either in 2014 or shortly before, but "revived" in January 2015 "after a long period of stagnation" (https://cloudyscience.wordpress.com/updates/, last visited February 14, 2017). It is defined as a "partner site" by *ArXiver* (http://arxiver.net/, last visited February 21, 2017). "The goal of Cloudy Science is to present automatically generated wordclouds that give a researcher insight into the content of a paper, offering another way to quickly judge whether a paper might be […] relevant to them. It currently only focuses on arXiv's astro-ph" (https://cloudyscience. wordpress.com/about/, visited February 14, 2017). Readers can assign "likes" to single papers, but this feature appears to have been very scarcely used; also, papers can be shared to Twitter, Facebook and Google+. At the moment of writing, *Cloudy Science* is "brought to you" by Australian postgraduate student Vanessa Moss (Sydney Institute for Astronomy, http://sydney.edu.au/science/people/vanessa.moss.php, visited February 14, 2017).

ArXivist (http://arxivist.com/, last visited March 13, 2017) and *ArXiv Sanity Preserver* (http://arxiv-sanity.com/, last visited March 13, 2017) were both born in 2016; they also share the feature of using readers' preferences – as provided in a web 2.0 environment – for customizing ArXiv daily updates for users accordingly. Both developers (Anton Lukyanenko and Andrej Karpathy respectively) are US-based and are active in the mathematic field (the former) and in computer science (the latter), which suggests not to get into further details in the present context.

3.2. ArXiv-Based Overlay Journals (3.a.)

Mathematicians, computer scientists and physicists have notoriously shown a rather active attitude about the implementation of ArXiv-based overlay journals ([28], [29]; early examples in [33]). Meaningful samples of some computer scientists' views on the subject, supplemented by a specific project, can be read at the blogpost "Scientific

journals in the e-publishing age", written by computer scientist Philip Thrift on his blog "Occupy publishing" on February 1, 2012 and widely commented (http://occupy publishing.blogspot.it/2012/02/scientific-journals-in-e-publishing-age.html, last visited March 14, 2017). New projects have recently enriched this scenario, such as mathematician Tim Gowers' *Discrete analysis* (http://discreteanalysisjournal.com/, 2015, last visited March 17, 2017; announcements on Gowers' blog, e.g. https://gowers. wordpress.com/2016/03/01/discrete-analysis-launched/, last visited March 17, 2017).

New achievements have been accomplished in physics, too and will be accounted for in more detail.

- **3.a.1.** Dutch platform *Scipost* (https://www.scipost.org/, last visited March 20, 2017), born in 2016, presently provides two ArXiv overlay journals, "SciPost Physics" and "SciPost Physics Lecture Notes", whose contents are published under the CC-BY 4.0 license (https://www.scipost.org/FAQ, last visited March 21, 2017) and equipped with DOIs. Commenting is possible for registered *SciPost* contributors. "Scipost Physics" publishes research articles in experimental, theoretical and computational physics, including cosmology and astroparticle physics (https://www.scipost.org/journals/scipost_physics/ about, last visited March 20, 2017); as at writing, three issues have been published for a total of twenty-five accepted articles. Outstandingly, *Scipost* is endorsed by the Netherlands Organization for Scientific Research (NWO) (https://www. scipost.org/, last visited March 20, 2017), which presently supports for operational costs (https://www.scipost.org/FAQ). *Scipost* relies upon a wide, international editorial college of almost fifty members (as at March 21, 2017); the advisory board includes eleven academics from the Netherlands as well as from Italy, France, Switzerland and Germany. This resource is listed in [1].
- **3.a.2.** *Quantum* (http://quantum-journal.org/, 2016, last visited March 17, 2017) is an ArXiv overlay journal for quantum physics and related fields: "all papers submitted to Quantum must be listed on (or cross-listed with) the arXiv section quant-ph. In case of acceptance, the final version must be uploaded to the arXiv before publication" (http://quantum-journal.org/about/faqpage/, last visited March 21, 2017). Little more than three months after submission opening (November 20, 2016, cfr. http://quantum-journal.org/quantum-opens-for-submissions/, last visited March 21, 2017), *Quantum* is reported to have received over 40 submissions (http://quantum-journal.org/40-submissions/, last visited March 21, 2017). In an interview to the blog "Scholastica", co-founder Christian Gogolin states that "we were strongly inspired by other arXiv overlay journals; perhaps *Quantum's* distinguishing feature is the strong emphasis on community involvement" (http://buff.ly/2k5yqUx, last visited March 21, 2017). The fourty-members editorial board is international, with a prevalence of European scientists. Accepted papers will be published under a CC BY 4.0 license and will receive a DOI through Crossref. "To provide a long term perspective for the journal, Quantum is backed by a democratic non-profit society", (the Verein zur Förderung des Open Access Publizierens in den Quantenwissenschaften based in Vienna; http://quantum-journal.org/ impressum/, last visited March 21, 2017). A subreddit has been provided for discussions, https://www.reddit.com/r/quantumjournal/ (last visited March 21,

2017); Twitter and Facebook accounts are active as well, with 983 and 793 followers respectively as at March 21, 2017. In the field of astrophysics, a single example of ArXiv-based overlay journal has seen the light up to the moment (3.a.4., *infra*), but previous, sometimes advanced efforts in this direction had been made before within this scholarly community.In a blog comment to the later experience of 3.a.4. (*infra*), Daniel Fischer witnessed that about 1997 some researchers attending a conference in Germany had already conceived the idea of creating a journal "ArXiv mated with open peer review" [...] the name that journal should be given: "Open Astronomy", but "the concept never saw the light [...]". It seems credible that the same consideration has arisen elsewhere too in the global astrophysical community; this is proved as at June 2005 among a group of young but very mindful British astrophysicists contributing to CosmoCoffee, which included Antony Lewis and Sarah Bridle (http://cosmocoffee.info/viewtopic.php?t=27 6, last visited February 8, 2017). Some years later, two relevant projects reached far more advanced, though different, stages of fulfilment and appear to be or have been very well-rooted within the astrophysical community.

- **3.a.3.** The first one was the impressing *RIOJA Project* (Repository Interface to Overlaid Journal Archives), who has been recognized as the first overlay project in astrophysics [34]. This initiative, born in 2007, was supported by prominent scholarly institutions both in the UK and in the USA: University of Cambridge, Imperial College London, University of Glasgow, UCL, Cornell University, and funded by JISC. It was preceeded by a careful examination of the side conditions inclusive of a wide survey among 683 researchers by Polydoratou & Moyle ([16], [34]), as well as by a feasibilty study [35]. A final report was also provided in 2008 [36]. Although a demonstrator implementation was achieved, as witnessed by the final report, it results that no overlay journal has subsequently been built on that technology as at September 2015. The *RIOJA Project* has been accounted for by relevant studies ([37], [28] and [29]).
- **3.a.4.** Five years later (2012), and still in a UK context, a new project was launched by cosmologist Peter Coles, *The Open Journal of Astrophysics* (http://astro.theoj.org/). The launch was made through the blogpost *A Modest Proposal – The Open Journal of Astrophysics* [38], published by Coles on his blog "In the dark" on July 17, 2012 – following previous discussions within and outside this blog. The proposal was expressed as follows: "[..] My suggestion is that we set up a quick-and-easy trial system to circumvent the traditional publishing route. The basic is that authors who submit papers to the arXiv can have their papers refereed by the community, outside the usual system of traditional journals. I'm thinking of a website on which authors would simply have to post their arXiv ID and a request for peer review. Once accepted, the author would be allowed to mark the arXiv posting as "refereed" and an electronic version would be made available for free on the website" (*ibid.*); the accepted articles are published under a CC-BY license and the reviewer comments can be disclosed "at the joint discretion of the authors and reviewers" (http://astro.theoj.org/about, last visited March 17, 2017). Coles' proposal raised interest within the community, as demonstrated by almost 70 qualified comments received by his blogpost from other scholars within the following fortnight (plus others successively). Interestingly, one of the

comments came from one of the researchers previously involved both in the mentioned lively discussion on CosmoCoffee in June 2005 and later in the Rioja project, who now is a member of OJA's editorial board (http://astro.theoj.org/about, retrieved February 8, 2017). Also, Robert Simpson (see 3.c.5. above) collaborated to the code development (https://telescoper.wordpress.com/tag/the-open-journal-for-astrophysics/, visited February 14, 2017). On 22 December 2015 it was announced that "The Open Journal is Open for Submissions" [39]; shortly after, *Nature* published an article about this initiative [40]. As of March 2017, three papers appear at http://astro.theoj.org/ as "accepted".

3.3. Other web 2.0 platforms and experiences with prevalent commenting features (3.b)

- **3.b.1.** A web 2.0 tool aimed at providing ArXiv with commenting features was *Naboj*, created in 2005 (http://www.naboj.com/, last visited February 8, 2017) and now apparently abandoned. Its name appears to be an anagram of its creator's Bojan Tunguz first name; Tunguz reports to have been "an international [physics] student and faculty at various US colleges and universities" (http://www.tunguz.com/About/, last visited March 1, 2017). The tool is described as "a dynamical website that lets you review online scientific articles. […] the [...] articles that are available for review are those that have been posted at Los Alamos ArXiv and PubMed Central". In fact, the papers commented come almost exclusively from ArXiv. The resource seems to have been used by a restricted number of people active in the physics domain: from 2005 to 2010, 23 comments were made, almost entirely on physics papers. More than 78% of the comments were made during the first two years of Naboj's existence. Rather interestingly, comments themselves could be voted as "useful" or "not useful". The last review available on *Naboj* results to have been made on February 18, 2010 (http://www.naboj.com/recent_reviews.php?s =0&np=5, visited February 8, 2017). Naboj was accounted for by [11] and [37], as well as mentioned by [8].
- **3.b.2.** *Scirate* (https://scirate.com/, last visited March 21, 2017) was originally created by US physicist and computer scientist Dave Bacon in January 2007 (http://scienceblogs.com/pontiff/2010/06/07/what-to-do-with-scirate/, dated June 7, 2010, and https://groups.google.com/forum/#!topic/scirate/WAHKx 8TAUo8, dated October 16, 2011, both last visited March 22, 2017). In early 2012 it was rewritten by Bill Rosgen (https://groups.google.com/forum/#! topic/scirate/wnjkKSZYZkI, dated April 24, 2012, last visited March 22, 2017); its code is on GitHub and user data are published under a Creative Commons license (https://scirate.com/about, last visited March 21, 2017). The information on its features appears to be synthetic on the website - at least for non-registered users ("Follow arXiv.org categories and see the highest ranked new papers; scite [i.e.: vote] papers and subscribe to categories, sign up to customize your view of the site" (*ibid.*), but the interface is rather self-explanatory. ArXiv's categories which are presently available result to be: astrophysics, condensed matter, nonlinear sciences, "more physics", mathematics, computer science, quantitative biology, quantitative finance and statistics. Users need to have registered. For a temptative assessment of its usage, the ArXiv papers which had been "scirated" at least twice during the

year from 6 April 2015 to 6 April 2016 were 53; 2 of them have been commented. The resource appears to be more widely used by mathematicians and physicists, which is probably related with what seems to be the predominant research interest within the *Scirate* working group ("the Scirate Collaboration", https://scirate.com/about, last visited March 21, 2017), i.e. quantum physics. *Scirate* is listed in [1].

- **3.b.3**. *VoxCharta* (http://harvard.voxcharta.org, 2009, last visited March 17, 2017) is somehow peculiar among the tools in this group, inasmuch it provides rating and commenting features for ArXiv papers for a practical aim: selecting papers for subsequent real-life scholarly discussions. Thus, *VoxCharta* seems somehow to bridge the gap between the two different ecosysytems of virtual and real-life scholarly communication. This might be the reason for its adoption also among research groups which have demostrated to appreciate more traditional means of internal communication such as conversations or email exchanges ([17], [18]). *VoxCharta* is self-defined as "a clone of arXiv used primarily for astronomy and astrophysics paper discussions. Users have the ability to vote for papers they would like to talk about at the next local discussion session. All papers that received votes since the previous discussion appear in an "agenda" at the top of the main page, sorted by the number of votes each paper receives […]. The basic idea is that everyone who is planning to go a department astro-ph discussion should use Vox Charta to "vote up" papers they find interesting. Additionally, each paper has a "comments" link that allows you to post things that people who are reading astro-ph may find interesting, or might be useful to look at when talking about the paper at a discussion section. Viewing the web page can be done anonymously, but voting and commenting on papers requires an account. As quite a few spammers try to sign up for accounts, each department that uses Vox Charta has a person designated as a "liaison" who approves all new accounts for that department." (http://harvard.voxcharta.org/about/about-this-website/, last visited March 7, 2017). *VoxCharta* was designed and is maintained by James Guillochon, (http://harvard.voxcharta.org/about/about-this-website/, last visited March 7, 2017), currently an Einstein Fellow at the ITC at Harvard-Smithsonian Center for Astrophysics (https://astrocrash.net/about-me/biography, last visited March 7, 2017). Thanks to the author's courtesy, we know that the first discussion took place on July 28, 2009 and that shortly after, due to other institutions' expressions of interest, the ability for the site to support multiple institutions simultaneously was added. The original number of ArXiv categories was gradually extended including, e.g., high energy physics. *VoxCharta* is listed in [1].
- **3.b.4.** Another prominent experience is *PaperRater* (http://www.paperrater.org/, last visited March 17, 2017), created by young German astrophysicist Peter Melchior in 2010 and listed in [1]. PaperRater's Getting Started Guide states the tool's fundamentals: "PaperRater.org reads the daily submission to any category of arXiv and searches for published papers onThe SAO/NASA Astrophysics Data System (ADS) […]. You can help PaperRater.org to help all of its users [...] by rating, tagging or commenting papers. You can rate every paper only once, but you can change the rating later at any time. Your rating is anonymous. The distribution of ratings will be shown once a sufficient number of ratings is reached. You can

add as many tags to each paper as you like, but three is often a good number. These tags can be updated at any time. [...] No other user can find out, which papers you rated or even what your rating was, nor what tags you chose. In contrast, comments are meant to be public. If you […] decide that you want to stay anonymous [...] you can choose to do so for any comment independently" (http://www.paperrater.org/help/getting-started.html, dated March 3, 2012, last visited February 28, 2017)."Sharing has been enabled with Twitter, Facebook, Google+, and LinkedIn (http://paperrater.org/blog/social-bookmarking-and-altmetrics.html, dated August 20, 2012, last visited February 28, 2017). PaperRater's interface looks user-friendly and the tool's mission is clearly stated in the first post of the dedicated blog (October 8, 2010): "The peer review process has a long-standing tradition in improving manuscript quality [...] However, it is not infallible [...] as students and researchers we all read papers daily, evaluate and judge them [...] this process is able to improve a paper's quality beyond what a single referee could achieve. If the joint wisdom of the community could be bundled. This is what PaperRater.org is all about: to augment and eventually replace the intransparent process of peer review as a lone quality measure for publications by a public one" (http://www.paperrater.org/blog/mission-statement.html, last visited March 17, 2017). In March 2016 the author's kindness made it possible to give some figures of users' response to *PaperRater* over time. Reads had increased significantly from 2010 (1467) to 2012 (2964), starting then to decrease (678 in 2013) until the last year available (363 in 2015). Ratings had reached a maximum during the first year (111), were 92 in 2012 and decreased markedly after 2013 (when they were 20). Registered users were 558 - as at March 20, 2016.

- **3.b.5.** The idea of *YouASTRO* (http://youastro.dyndns.org:43905/, last visited March 17, 2017) came during a post-conference international evening colloquium among astrophysicists – as kindly reported from project co-creator, Italian astrophysicist Fabrizio Bocchino (Italian National Institute for Astrophysics), who wrote the YouASTRO code. The other involved researchers were Javier Lòpez-Santiago, Juan F. Albacete-Colombo and Niccolò Bucciantini. The tool was operative in 2011, but some comments to an article published in May 2010 can date the tool back to the year before. The project was presented to the ADASS conference in November 2011 [41]. The definition on the website states that "YouASTRO is a web application which allows us to leave comments and give rating to refereed astrophysical papers. For now, the papers which can be commented are only the papers appearing on the SAO/NASA Astrophysics Data System [i.e. the widest database for the astrophysical literature worldwide] […] The YouASTRO Board of Editors think that the YouASTRO "leave a comment" feature can be of great benefit to the scientific community, if used widespreadly. It promotes the online scientific discussion focussed on papers, it is a way to pinpoint strong and weak points of papers, in the framework of a general and continuous improvement of the quality of scientific publications, and the overall advance of science" (http://youastro.dyndns.org/faqs.html, last visited March 17, 2017). Suitable consideration was had both for authors' sensibility and for statistical significance: "registered users can vote a paper, one vote per paper [...] rating goes from 1 (very poor) to 10 (excellent). Ratings are always

anonymous [...] YouASTRO only shows average ratings [...] after more than 3 ratings have been received". The placement in the web 2.0 ecosystem occurs clearly, but the focus results to be on published articles rather than on preprints (among other clues: "comments to astroph papers will be automatically migrated to the refereed version (...) when it appears"). As at June 2016, *YouASTRO* had 434 registered users (were 100 on 20.12.2011, http://youastro.dyndns.org/news.html, visited July 4, 2016). Peaks of activity were achieved during the first years of operativity, as witnessed by the data from two public tables of YouASTRO top-ranked papers (http://youastro.dyndns.org:43905/#highest, last visited March 17, 2017). Among the top 10 most commented papers, 10% were published in 2009 and in 2012, 60% in 2010, 20% in 2011; 64.28% of the public comments they received were made in 2010, 21.42% in 2011. 70% of top 10 most recently commented papers were published in 2013, none afterwards; 85.70% of their public comments were equally divided between 2012 and 2013. Public comments result to be only 34.69% and, among them, anonymity is the standard (92,08%), as understandable in a small community of users.

- **3.b.6.** Presumably at the beginning of 2012, young mathematician Ralph Furmaniak, a PhD student at Stanford University by that time, created *ArXaliv*. When publicising his tool on a forum for colleagues on March 28, 2012, Furmaniak wrote "I have set up the reddit software to work with the arxiv database [..] Each day it will update the list with the latest papers and you can upvote, downvote, comment, save links of interest, search, post new links, or create your own communities/arxalivs to post in or have others post links or writings of interest to them. [...]" (http://publishing.mathforge.org/discussion/ 83/, last visited March 17, 2017). Exactly one year later, Furmaniak posted ArXaliv's codebase on GitHub in case "one day [...] there are other people interested" (https://github.com/rfurman/arxaliv, last visited March 17, 2017). In fact, the tool looked "defunct" to another mathematician on a blogpost dated November 12, 2013 and is presently no more available at the original website http://arxaliv.org/.Also to the mathematic field and to 2012 seems to have belonged the project of *arXiv Review* (no more available at http://arxiv-review.org/ as at March 2017). Apparently, it was intended as an ArXiv overlay journal with commenting and rating features. Related documentation can be found at http://occupypublishing.blogspot.it/2012/02/guidelines-for-arxiv-review.html and https://plus.google.com/113026609770667182181, last visited March 20, 2017.
- **3.b.7.** *Selected Papers* (https://selectedpapers.net/) was developed in 2013 by US computational biologist Christopher Lee (see the post https://johncarlosbaez.wordpress.com/2013/06/07/the-selected-papers-network-part-1/ on US mathemathical physicist John Carlos Baez' blog "Azimuth", last visited 27 February 2017; see also Lee's blogpost https://johncarlosbaez.wordpress.com/2013/07/12/the-selected-papers-network-part-3/ dated July 12, 2013, last visited 27 February 2017, and [42]). This tool – listed in [1] –, which enabled commenting on ArXiv papers, had distinctive features among which using Google+ authentication and seems to have raised interest among researchers. In March 2016, anyway, *Selected Papers* resulted to be unaccessible, which remains unchanged at the moment

of writing, although a detailed documentation about this project is still available at http://docs.selectedpapers.net/ (last visited March 17, 2017). Due to this situation, and to Lee's specific research area, a more in-depth account of this resource won't be provided.

- **3.b.8.** *Xiv* (https://www.reddit.com/r/Xiv/, last visited March 17, 2017) is "an interdisciplinary reddit for discussing papers submitted to arXiv (http://arxiv.org/), an open-access journal for e-Prints." It "aims to support arXiv by providing an open forum for papers and by calling attention to great papers" (https://www.reddit.com/r/Xiv/, last visited March 7, 2017). Registered users – who result to be 431 as at March 7, 2017 - can submit text posts or arXiv abstracts, and may receive comments from other registered users. Deductively, *Xiv* made its debut in 2014. As at March 7, 2017, posts – which can be upvoted – result to be 47, 41 of which were published in 2014, 2 in 2016, 4 in 2017; 53.19% of them received one or more comments. Thirty-eight posts (80.85%) have a tag and these are in many subfields of physics, included astrophysics, though the great majority are in quantum physics. There are two moderators, who appear to be active in quantum physics; only their nicknames are available and apparently they can't be contacted by non-members. It can be noted that Reddit hosts further relevant subreddits, e.g. in cosmology and in astronomy, but the discussions don't appear to be based upon ArXiv papers.
- **3.b.9.** *ArXiv Analytics* (http://arxitics.com/, last visited March 17, 2017) was developed in 2014 by Chinese graduate student on high energy physics Zan Pan (Institute of Theoretical Physics, Chinese Academy of Sciences of Beijing), who is also the resource's maintainer. Collaboration and feedbacks were gained also from other nations (https://github.com/arxitics/arxiv-analytics/network /members, last visited March 6, 2017). This resource is defined as "a web portal that offers more features and a better user interface for reading eprints provided by arXiv.org. You can search, subscribe, bookmark, review eprints, and interact with the community. The project is still under development." (http://arxitics.com/site/about, last visited March 1, 2017). ArXiv Analytics' main functions appear to be: "advanced search interface to find articles" (includes sorting by "reader counts" or by "rating score"); configure eprint subscriptions - by several parameters including keywords, tags, authors; manage one's preferences/activities in a personal account (e.g. bookmarks, reading, rates, votes); post reviews and make comments; openly upload one's original content that have not been published online (under CC BY-SA 4.0 license; all from http://arxitics.com/, visited March 1, 2017), thus gaining twenty "reputation points" for each document (http://arxitics.com/help /documents, visited March 1, 2017). The reputation system (http://arxitics.com /help/reputation, last visited March 1, 2017) shows some apparent oddity such as losing reputation points when rating an article or voting a review (-1 in each case, but +5 for publishing a new review); this might be due to a value system that encourages sharing significantly (+20 for sharing a document) rather than judging on a small scale. Thanks to Zan Pan's courtesy we get to know that there are 295 registered users at present, many of which are Chinese students; for them, *ArXiv Analytics* also provides a chat. The number of rated papers is presently "less than 100" (the feature is still experimental).

- **3.b.10.** Another tool which appears to have been tailored upon ArXiv in a web 2.0 environment was *ArQuiv* (http://arquiv.org/), which was presumably born in 2014. It was retrieved and visible on March 23, 2016 but is no more available as at writing (March 2017). Anyway, even more than it happens with other similar tools, the information supplied on the website was poor for those not registered, so that for example it was impossible to credit ArQuiv to its authors otherwise than "arQiv.org has no affiliation with arXiv.org or Cornell University" – and the homepage description was limited to: "arQiv.org: revolutionize scientific discussion by connecting readers and authors. To discuss any arXiv article, just change **"X"** to **"Q"** to visit arQiv". One of the ideas seemed to be to modify the typical url of an ArXiv paper in order to enable comment reading. *ArQuiv*, anyway, clearly belonged to the family of platforms aimed at supplementing ArXiv with web 2.0 features.
- **3.b.11.** In 2015 young physicist Florian Beutler and cosmologist Morag Scrimgeour created *Benty Fields* (http://www.benty-fields.com/, last visited March 17, 2017). The resource is described as "the academic network with daily papers and journal club organizer" (*ibid.*). In fact it's more than this as it "allows you to read the daily arxiv publications in a user friendly environment [...] You can organize papers in a library, including a reading list. If you are member of a journal club, you can directly vote for papers to put them on the agenda for the next journal club. If you want to point out a paper to a colleague you have the Recommend Paper option. You can create a journal club and invite your colleagues to join. The journal club agenda shows all the papers voted for by members of your journal club. Under My Profile you can let others know about your academic career and interests. [...] Benty-fields is organized like a social network, so you can follow your colleagues and they can follow you. The social network aspect is still under development, but already there are advantages when following others. For example you can easily contact them, send them messages or read their profile" (http://www.benty-fields.com/, as retrieved on April 14, 2016). A remarkable characteristic is the tool's social networking feature, which definitely locates this experience in the post-social networks era. Consistently, *Benty Fields* appears to be integrated with Facebook, Twitter, Google+ and LinkedIn. Registration is required. The interface is agreeable and the tool is sophisticated enough to provide a section about Terms and conditions as well as a privacy policy (http://www.benty-fields.com/tos#priv, last visited March 17, 2017).

4. Conclusions

The availability of an established and comprehensive database of open access literature in physics and astrophysics such as ArXiv is likely to have fostered the birth of a significant number of web 2.0 experiences in these research fields and may have shaped them as electively literature-based. This seems to have happened rather early in some cases and anyway independently from ArXiv's adoption of a web 2.0 setting.

In this respect, the vision of ArXiv as a founding ground for physicists' accreditation within their community results to be appropriate, not so much as the elegant socio-hermeneutical proposal of a database having a legitimizing role for itself among physics researchers [19] but rather, in addition to the sanctuary, like a function

of early repository for the discipline's literature – as a lively catalyst for web 2.0 scholarly exchanges within astrophysics and physics.

On the basis of the 2016 users survey and analysis conducted, the ArXiv team appears now to be somehow mediating between the "conservative" and still prevailing attitude, focussed on keeping the platform "to the core mission", and an emerging 2.0 trend which favours innovations such as rating and commenting on top of it ([25], [26]). The ArXiv-Next Generation initiative, which has only just started ([26]), will perhaps mark a change in this respect, for as much as it's possible to understand at the moment.

As for the tools here surveyed, and again for as much as it has been possible to observe, the outcomes appear to have been often affected by the physical limits of the local circles involved. For example, it has been found repeatedly that researchers committed to a project didn't know about the existence of parallel efforts among other colleagues, or that the news about a project's development didn't circulate well enough among interested people outside the circles – as witnessed by blog comments. An apparently rare piece of research about extending ArXiv's features to open peer-review and publishing [43] doesn't mention any of the ArXiv-based commenting resources for scholars which were already in place by that time according to our findings. All this testifies that, although obviously internet-based, many of these experiences were in fact very local level-dependent, at least during the first years of their existence. All in all, actually, web 2.0 tools in astrophysics seem to have been strongly affected by local circumstances, both for the good (e.g. motivation) and for the bad – restricted scholarly communities can seldom provide the critical mass for a new tool to take off, especially when validation is involved.

For a significant part, the web 2.0 tools which have been accounted for above appear to have been created in a few astrophysical circles, mainly concentrated in the UK and in the USA; specially lively environments have proven to be the University of Sussex and Harvard University. Following the academic pathway of some of the creators of these tools, who sometimes were foreign students or researchers, might contribute to the history of web 2.0 commenting platforms in astrophysics. This anyway goes beyond the aim of the present study and is probably more appropriate for retrospective future research.

There are clues that this aspect, and the common local perspective, might be changing in the latest years – approximately starting around 2012, e.g. with a stronger presence of multi-national development teams. This might have to do with the diffusion of worldwide sharing platforms such as GitHub, although this is a simple hypothesis. 2012 also seems to be the peak of one of the time flows in which the experiences surveyed seem to have debuted – which is in line with Peter Melchior's remark as expressed in a comment to mathematician Philip Thrift's blogpost ("the internet seems to be bursting these days with ideas about how to improve/replace peer review and classical journal. This is a very exciting time. [...]", http://occupypublishing.blogspot.it/2012/02/scientific-journals-in-e-publishing-age.htm dated February 1, 2012; last visited March 20, 2017).

On the whole, the astrophysical and physical communities look globally far from unaware or idle with regard to new communication and validation tools in the 2.0 ecosystem.

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