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Quantitative Study of the Geographical Distribution of the Authorship of High-Energy Physics Journals

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Abstract

The recent debate on Open Access publishing in High-Energy Physics has exposed the problem of assessing the scientific production of every country where scholars are active in this discipline. This assessment is complicated by the highly-collaborative cross-border tradition of High-Energy Physics research. We present the results of a quantitative study of the geographical distribution of authors of High-Energy Physics articles, which takes into account cross-border co-authorship by attributing articles to countries on a *pro-rata* basis. Aggregated data on the share of scientific results published by each country are presented together with a breakdown for the most popular journals in the field, and a separation for articles by small groups or large collaborations. Collaborative patterns across large geographic areas are also investigated. Finally, the High-Energy Physics production of each country is compared with some economic indicators.

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1 Introduction

Recent years have witnessed the onset of a world-wide debate on Open Access publishing. The tenets of Open Access are to grant anyone, anywhere and anytime access to the results of publicly-founded research [1]. Several ways exist towards this goal, some of which require a deep change of the current business model of scientific publishing. Today, the reader community supports the costs of scientific publishing by purchasing journal subscriptions. These costs are driven by the costs of organising the peer-review service, as well as copy-editing and typesetting. Some Open Access business models are based on the fact that these costs are effectively linked to services offered to authors, more than to readers, and are therefore to be met from the author side and not any longer from the reader side as it is presently the case. This is the business model proposed by the SCOAP^3 initiative (Sponsoring Consortium for Open Access Publishing in Particle Physics) [2] which strives for Open Access in High-Energy Physics (HEP). This consortium would collect funds from all countries with an active HEP community in order to meet the costs of the organisation of the peer-review service. This practical approach requires a detailed understanding of the contribution of different countries to the production of HEP articles. The objective of this study is to assess the distribution of the HEP scientific production among countries, and lay down the quantitative foundations for this model.

HEP is commonly regarded as one of the most international and collaborative scientific disciplines: large experiments at accelerators bring together thousands of scientists from around the planet, while theoretical HEP predates by a long time present-day cross-border communication as a truly global enterprise. As a consequence of this well-established cross-border tradition, co-authorship of HEP articles by scientists affiliated to different countries is very frequent. This phenomenon complicates bibliometric studies aimed at evaluating the contributions of different countries to the production of HEP articles. This issue was first discussed in a previous study [5] which analysed the HEP production of different countries based on *pre-prints* submitted to the HEP section of the popular `arXiv.org` repository [3, 4]. In that study, co-authors were assigned to different countries on a *pro-rata* basis. However, the HEP part of `arXiv.org` does not entirely overlap with the content of published journals: not all authors submit their pre-prints to this repository and HEP journals often cover 10%−30% of content beyond the scope of the HEP sections of `arXiv.org` [2]. This article analyses in detail the pro-rata contribution in leading HEP journals, extending and complementing the previous study.

This study is based on HEP articles published in 2005 and 2006, selected and analysed as presented in Section 2. Section 3.1 presents results on the geographical distribution of the HEP authorship and its breakdown for individual journals. Section 3.2 discusses the number of authors per article and compares the geographical distribution of the HEP authorship for articles by individuals and small groups or large collaborations. Section 3.3 discusses global collaborative patterns. Section 3.4 presents additional studies on the correlation between the share of HEP production of several countries and some economic indicators.

2 Data Sample

HEP articles appear in several dozens of journals. However, five "core" journals, with predominantly HEP content, account for the vast majority of the HEP literature [2, 5]. These are:

- *Physical Review D* (published by the American Physical Society),

- *Physics Letters B* (Elsevier),
- *Nuclear Physics B* (Elsevier),
- *Journal of High Energy Physics* (SISSA/IOP),
- *European Physical Journal C* (Springer).

Two additional "broad-band" journals cover many areas of physics and are popular with HEP authors:

- *Physical Review Letters* (American Physical Society),
- *Nuclear Instruments and Methods in Physics Research A* (Elsevier).

These two journals carry about 10% and 25% HEP content, respectively [2]. All articles published in the five "core" journals in the years 2005 and 2006 are considered in this study, for a total of 9 986 articles. In addition, 1 315 HEP articles from the two "broad-band" journals are selected according to their subject [6]. The selection criteria are the same as used for their inclusion in the HEP reference database, `SPIRES` [7][3]. Editorials, errata and other material are excluded from the study; conference proceedings, which sometimes appear in *Nucl. Instr. Meth. A*, are also not considered.

Table 1 presents the numbers of articles considered in this study for each of the journals under investigation. The largest title is *Phys. Rev. D*, the two second largest are the *Journal of High Energy Physics* and *Phys. Lett. B*.

The analysis is based on two pieces of information for each of the 11 301 articles: the number of authors and their affiliation. All affiliations are compared with a list of HEP institutes worldwide and each author is uniquely assigned to a country. CERN, the world's largest, international, HEP laboratory is considered as an additional country.

Medium- and long-term visits to different institutes and major laboratories are common practice among HEP scholars; hence, about 5% of the authors in the data sample have two or more affiliations. Three principles are followed to assign authors with multiple affiliations to a single country, in the order of importance as presented below.

1. If one of the multiple affiliations of an author is CERN, the author is assigned to CERN.
2. If one of the multiple affiliations of an author is a HEP laboratory, the author is assigned to the host country of that laboratory.
3. The remaining multiple-affiliation cases are resolved by assigning the author to the country with the largest *per-capita* gross domestic product (GDP) [8]. If among the multiple affiliations there are two or more HEP laboratories, the same principle is applied, by considering the per-capita GDP of the corresponding host countries.

For each article, a fraction of the article is attributed to a given country, corresponding to the number of authors affiliated to that country, divided by the number of authors of the article. The sum of these fractions over all the articles in the sample, divided by the total number of articles, defines the pro-rata share of HEP production of a particular country.

[3]The SPIRES database is hosted at SLAC, the Stanford Linear Accelerator Center in California, and jointly compiled together with DESY, the Deutsches Elektronen-Synchrotron in Hamburg, and Fermilab, the Fermi National Accelerator Laboratory in Illinois.

3 Results

3.1 Distribution of the HEP Production by Country

The share of HEP publications among different countries is presented in Table 2 and Figure 1. Articles from the years 2005 and 2006 are considered. Results for the individual years do not show large variations with respect to this average. To our knowledge, this is the first detailed study of the authorship of HEP journals which takes into account the co-authorship phenomenon.

The results on the HEP production by country are further combined in three groups: CERN and its Member States[4], which, to a good approximation, represent the European share of HEP, the United States, and the remaining countries. Their contributions are 40.8%, 24.9% and 34.3%, respectively, as shown in Figure 2. The largest contributions in the "Other Countries" group are from Japan and China, with 7.2% and 5.3% of the total HEP production, respectively.

Tables 3−6 and Figures 3−9 present the contribution from each different country to the individual journals. There are considerable variations from one journal to the other, reflecting local traditions and habits. These traditions are further explored by studying the geographical distribution of the authorship of two categories of journals: those published in Europe: *Journal of High Energy Physics*, *Phys. Lett. B*, *Nucl. Phys. B*, *Nucl. Instr. Meth. A* and *Eur. Phys. Journal C*, and those published in the United States: *Phys. Rev. D* and *Phys. Rev. Lett.*. The results are presented in Figure 10. Authors from CERN and its Member States, *i.e.* European authors, account for 47.4% of the content for European journals and 33.4% for American journals. Authors from the United States account for 18.9% of the content for European journals and 31.6% for American journals. American journals are equally used by authors worldwide while European journals are slightly preferred by European authors.

3.2 Articles with few Authors and Large Collaborations

Figure 11 presents the distribution of the number of authors for the 11 301 articles considered by this study. Structures corresponding to articles by large scientific collaborations are clearly visible. Restricting the plot to articles with less than 25 authors shows more clearly that the vast majority of the article is authored by less than 10 authors. Table 8 presents the fraction of HEP articles as a fraction of the number of authors for individuals and small groups. Only 19.0% of the articles are found to have a single author.

A study of HEP pre-prints submitted to the `arXiv.org` repository and subsequently published found that articles in theoretical HEP have on average 2.6 authors, while articles in experimental HEP have on average about 290 authors [5]. To a good approximation, articles with 10 or more authors are on experimental HEP and articles with less than 10 authors on theoretical HEP. The data sample under investigation is therefore divided in two parts. Those with less than 10 authors, which accounts for 89.6% of the total, and those with 10 authors or more, which accounts for 10.4% of the total. Articles with less than 10 authors have on average 3.1 authors.

Table 7 and Figure 12 present the share among different countries of HEP publications with less than 10 authors and 10 or more authors. Differences between the shares of articles with 10 or

[4]CERN Member States are: Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland and the United Kingdom.

more authors and the shares for the total sample derive from stronger traditions of some countries in experimental HEP when compared to theoretical HEP. These differencies are described by the ratio of the share of HEP publications with less than 10 authors and 10 or more authors, presented in Table 7 and Figure 13 for some selected countries.

3.3 Collaborative Patterns in HEP

The data sample allows a study of the collaborative patterns in HEP, to identify which groups of countries have the strongest collaboration ties. A simple approach is chosen, in which only three large geographical groups of authors are considered: those of CERN and its Member States, the United States, and the remaining countries. Each article is assigned to one of seven mutually-exclusive classes where

1. all the authors are associated to CERN or its Member States;
2. all the authors are associated to the United States;
3. no authors are associated to CERN or its Member States nor the United States;
4. in articles with at least two authors, at least one is associated to CERN or its Member States and one to the United States, but none to any other country;
5. in articles with at least two authors, at least one is associated to CERN or its Member States and one to other countries, but none to the United States;
6. in articles with at least two authors, at least one is associated to the United States and one to other countries but none to CERN nor its Member States;
7. in articles with at least three authors, at least one is associated to CERN or its Member States, one to the United States and one to some other country.

Figure 14 presents the fraction of HEP articles in each of these seven classes. About 5% of the HEP articles have authors from Europe and the United States and another 6% of the articles have authors from the three geographical groups.

3.4 HEP Scientific Production and Economic Indicators

It is interesting to explore possible correlations between the share of HEP articles and some economic indicators. Figure 15 shows the share of HEP articles for all countries with a share above 0.2%, as a function of their GDP [8]. CERN is not considered in this study. The data are reasonably described by a linear function. A linear regression finds:

$$\text{Production} = (1.92 \pm 0.07) \times 10^{-5} \times \text{GDP (in } 10^9\$) + (0.033 \pm 0.017); \quad (1)$$

the correlation is about 95%. A smaller correlation is observed between the share of HEP articles and the GDP based on purchasing-power-parity, even though this could be a better indication of the cost of a researcher, as it is connected to the cost of living in a country. This two-dimensional distribution

is presented in Figure 16. There is no correlation between the share of HEP articles and either the GDP per-capita or the GDP based on purchasing-power-parity.

In Astronomy, the productivity per country was shown to scale as the square of the GDP divided by the population of a country [9]. The correlation between the HEP share and this indicator is presented in Figure 16. There is a smaller correlation than for the previous two indicators, showing a different underlying distribution by country of astronomers and HEP scholars.

Although Figure 15 presents a strong correlation, there is also a spread in the points as the level of HEP activity in a country is only partially dependent on the GDP. Indeed, the size of the HEP community in many countries reflects long-standing traditions. This is quantified by using Equation (1) to predict the share of HEP articles expected from each country which has an observed share above 0.2%. Figure 17 presents the ratio between the observed and expected shares of HEP articles. The higher part tags countries with a long-standing HEP tradition, while the lower part indicates countries with a community which is relatively small compared to the GDP of the country.

4 Conclusions

This article presents the results of the first bibliometric study of leading HEP journals which accounts for the widespread phenomenon of co-authorship. The share of the global HEP scientific literature of each country with an active HEP community is derived, and found to be strongly correlated with the GDP of the country, with some exception for countries with a strong HEP tradition dating back several decades. The international character of HEP research is confirmed by the fact that authors from Europe or the United States publish in both European or American journals.

The contribution of each country to the *corpus* of HEP literature is presented in Table 2 and Figure 1. These results constitute the basis of a "fair-share" scenario to divide the costs of a transition of HEP scientific publishing to Open Access [2]. This transition will be facilitated by the large collaborative links between Europe, the United States and other countries, presented in Figure 14: every country embracing Open Access will propagate this paradigm to many others, through these co-authorship ties.

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Journals	Publisher	Articles in 2005	Articles in 2006	Total Articles	Fraction of Total
Phys. Rev. D	APS	2 239	2 361	4 600	41%
Phys. Rev. Lett.	APS	389	384	773	7%
Journal of High Energy Physics	SISSA/IOP	853	1 022	1 875	17%
Phys. Lett. B	Elsevier	955	958	1 913	17%
Nucl. Phys. B	Elsevier	525	417	942	8%
Nucl. Instr. Meth. A	Elsevier	290	252	542	5%
Eur. Phys. Journal C	Springer	369	287	656	6%
Total		5 620	5 681	11 301	100%

Table 1: Distribution of HEP scientific literature over the largest journals in the field in the years 2005 and 2006.

Country	Share	Country	Share
United States	24.9%	Sweden	0.8%
Germany	9.1%	Taiwan	0.8%
Japan	7.2%	Belgium	0.7%
Italy	6.9%	Greece	0.7%
United Kingdom	6.7%	Australia	0.6%
China	5.3%	Denmark	0.6%
France	3.8%	Turkey	0.6%
Russia	3.4%	Chile	0.6%
Spain	2.9%	Argentina	0.5%
Canada	2.7%	Austria	0.5%
India	2.6%	Finland	0.5%
Brazil	2.6%	Hungary	0.4%
CERN	2.0%	Czech Republic	0.3%
Korea	1.8%	Ireland	0.3%
Switzerland	1.4%	Norway	0.2%
Poland	1.3%	Ukraine	0.2%
Israel	1.0%	Croatia	0.2%
Iran	0.9%	Slovenia	0.2%
Netherlands	0.9%	Armenia	0.2%
Portugal	0.9%	Bulgaria	0.2%
Mexico	0.8%	Other Countries	1.8%

Table 2: Contribution by country to the HEP scientific literature published in the journals spotlighted by this study. Co-authorship is taken into account on a pro-rata basis, assigning fractions of each article to the countries in which the authors are affiliated. The last cell aggregates contributions from countries with a share below 0.2%.

Phys. Rev. D		*Phys. Rev. Lett.*	
Country	Share	Country	Share
United States	30.0%	United States	41.4%
Japan	7.9%	Germany	9.7%
Germany	6.7%	Japan	7.1%
United Kingdom	6.2%	Italy	5.7%
China	5.9%	United Kingdom	4.7%
Italy	5.6%	France	3.8%
France	3.3%	Canada	2.9%
Canada	3.2%	Russia	2.7%
Brazil	3.1%	China	2.7%
Russia	2.9%	India	2.3%
India	2.7%	Spain	2.0%
Spain	2.5%	Switzerland	1.3%
Korea	1.6%	CERN	1.2%
Mexico	1.4%	Poland	1.1%
Poland	1.2%	Korea	1.1%
CERN	1.1%	Australia	1.0%
Portugal	1.1%	Israel	0.9%
Taiwan	0.9%	Netherlands	0.7%
Israel	0.9%	Brazil	0.6%
Switzerland	0.8%	Austria	0.6%
Belgium	0.7%	Portugal	0.6%
Iran	0.7%	Belgium	0.6%
Australia	0.7%	Mexico	0.6%
Chile	0.6%	Sweden	0.5%
Denmark	0.6%	Other Countries	4.2%
Argentina	0.6%		
Greece	0.6%		
Turkey	0.5%		
Other Countries	6.0%		

Table 3: Contribution by country to the HEP scientific literature published by the American Physical Society in *Physical Review D* and *Physical Review Letters*. Co-authorship is taken into account on a pro-rata basis, assigning fractions of each article to the countries in which the authors are affiliated. The last cells represent contributions from countries with a share below 0.5%.

Journal of High Energy Physics	
Country	Share
United States	23.4%
United Kingdom	10.6%
Germany	8.3%
Italy	7.7%
Japan	5.5%
Spain	4.8%
CERN	3.7%
France	3.1%
Canada	3.0%
Korea	2.6%
China	2.6%
India	2.6%
Netherlands	2.1%
Switzerland	1.7%
Brazil	1.6%
Israel	1.6%
Sweden	1.6%
Russia	1.4%
Iran	1.3%
Belgium	1.2%
Denmark	0.9%
Taiwan	0.7%
Australia	0.6%
Austria	0.6%
Turkey	0.6%
Czech Republic	0.5%
Ireland	0.5%
Greece	0.5%
Argentina	0.5%
Portugal	0.5%
Chile	0.5%
Other Countries	3.3%

Table 4: Contribution by country to the HEP scientific literature published by SISSA/IOP in the *Journal of High Energy Physics*. Co-authorship is taken into account on a pro-rata basis, assigning fractions of each article to the countries in which the authors are affiliated. The last line represents contributions from countries with a share below 0.5%.

Phys. Lett. B		*Nucl. Phys. B*		*Nucl. Instr. Meth. A*	
Country	Share	Country	Share	Country	Share
United States	16.9%	United States	18.7%	United States	21.3%
Germany	9.4%	Germany	14.6%	Germany	11.5%
China	8.7%	Italy	10.2%	Italy	10.7%
Japan	7.6%	Japan	7.4%	Japan	10.0%
Italy	7.0%	United Kingdom	6.9%	Russia	6.5%
United Kingdom	5.8%	France	6.1%	CERN	4.9%
Russia	4.4%	Russia	4.1%	United Kingdom	4.1%
France	4.1%	Spain	3.2%	France	3.9%
India	3.7%	Canada	3.2%	China	3.8%
Brazil	3.1%	China	2.8%	Switzerland	3.6%
Spain	3.0%	CERN	2.8%	Spain	1.9%
Korea	2.8%	Switzerland	1.9%	Sweden	1.5%
Canada	1.9%	India	1.5%	Canada	1.4%
Poland	1.9%	Brazil	1.4%	Poland	1.4%
Switzerland	1.5%	Denmark	1.4%	Korea	1.2%
CERN	1.3%	Iran	1.2%	Armenia	1.1%
Iran	1.2%	Hungary	1.2%	India	1.0%
Greece	1.1%	Netherlands	1.2%	Greece	1.0%
Argentina	1.0%	Greece	1.0%	Finland	0.9%
Chile	1.0%	Poland	0.9%	Netherlands	0.9%
Portugal	1.0%	Korea	0.9%	Ukraine	0.9%
Taiwan	0.9%	Australia	0.8%	Portugal	0.7%
Belgium	0.9%	Sweden	0.7%	Israel	0.6%
Sweden	0.8%	Taiwan	0.6%	Australia	0.5%
Israel	0.8%	Israel	0.6%	Norway	0.5%
Netherlands	0.8%	Portugal	0.6%	Taiwan	0.5%
Mexico	0.8%	Other Countries	4.2%	Other Countries	3.8%
Australia	0.7%				
Finland	0.6%				
Turkey	0.6%				
Ireland	0.5%				
Other Countries	4.1%				

Table 5: Contribution by country to the HEP scientific literature published by Elsevier in *Physics Letters B*, *Nuclear Physics B* and *Nuclear Instruments and Methods in Physics Research A*. Co-authorship is taken into account on a pro-rata basis, assigning fractions of each article to the countries in which the authors are affiliated. The last cells represent contributions from countries with a share below 0.5%.

Eur. Phys. Journal C	
Country	Share
Germany	17.1%
United States	10.5%
Italy	7.0%
China	6.8%
Russia	6.0%
Brazil	5.3%
United Kingdom	5.0%
France	4.4%
Poland	3.8%
CERN	3.5%
Japan	3.3%
India	2.8%
Turkey	2.3%
Austria	1.6%
Switzerland	1.6%
Spain	1.2%
Iran	1.2%
Croatia	1.2%
Sweden	1.1%
Canada	1.0%
Portugal	0.9%
Czech Republic	0.9%
Colombia	0.8%
Taiwan	0.8%
Israel	0.8%
Korea	0.7%
Belgium	0.7%
Mexico	0.6%
Algeria	0.6%
Netherlands	0.6%
Chile	0.6%
Finland	0.5%
Denmark	0.5%
Other Countries	4.2%

Table 6: Contribution by country to the HEP scientific literature published by Springer in the *European Physical Journal C*. Co-authorship is taken into account on a pro-rata basis, assigning fractions of each article to the countries in which the authors are affiliated. The last line represents contributions from countries with a share below 0.5%.

Country	$S(N \geq 10)$	$S(N < 10)$	Share	$S(N \geq 10)/S(N < 10)$
United States	31.9%	24.2%	24.9%	1.32
Italy	10.6%	6.5%	6.9%	1.64
Japan	9.3%	6.9%	7.2%	1.33
Germany	8.3%	9.2%	9.1%	0.90
Russia	5.9%	3.1%	3.4%	1.93
France	5.8%	3.5%	3.8%	1.66
China	5.7%	5.2%	5.3%	1.09
United Kingdom	4.5%	6.9%	6.7%	0.65
CERN	2.2%	2.0%	2.0%	1.07
Switzerland	1.4%	1.4%	1.4%	1.04
Korea	1.3%	1.9%	1.8%	0.72
Canada	1.3%	2.9%	2.7%	0.46
Poland	1.2%	1.3%	1.3%	0.89
Spain	1.0%	3.1%	2.9%	0.32
Netherlands	1.0%	0.9%	0.9%	1.10
India	0.9%	2.8%	2.6%	0.30
Australia	0.6%	0.7%	0.6%	0.88
Belgium	0.5%	0.8%	0.7%	0.70
Sweden	0.5%	0.8%	0.8%	0.59
Taiwan	0.5%	0.8%	0.8%	0.59
Brazil	0.5%	2.8%	2.6%	0.17
Slovenia	0.4%	0.2%	0.2%	2.55
Finland	0.4%	0.5%	0.5%	0.92
Mexico	0.4%	0.9%	0.8%	0.48
Greece	0.4%	0.7%	0.7%	0.57
Armenia	0.4%	0.2%	0.2%	2.05
Austria	0.4%	0.5%	0.5%	0.67
Portugal	0.3%	0.9%	0.9%	0.34
Czech Republic	0.3%	0.3%	0.3%	0.96
Hungary	0.3%	0.4%	0.4%	0.66
Israel	0.2%	1.0%	1.0%	0.23
Denmark	0.2%	0.7%	0.6%	0.34
Norway	0.2%	0.2%	0.2%	0.94
Ukraine	0.2%	0.2%	0.2%	0.66
Other Countries	1.0%	5.5%	5.1%	–

Table 7: Contribution by country to the HEP scientific literature for the subset of articles with 10 or more authors (first column), less than 10 authors (second column) and the total share, as from Table 2. The last column presents the ratio between the first and the second. The last line represents contributions from countries with a share of articles with 10 or more authors below 0.2%. To a good approximation, articles with 10 or more authors are on experimental HEP and articles with less than 10 authors on theoretical HEP.

Number of authors	Fraction of articles
1	19.0%
2	31.0%
3	23.1%
4	10.2%
5	3.5%
≥ 6	13.2%

Table 8: Fraction of HEP articles with few authors.

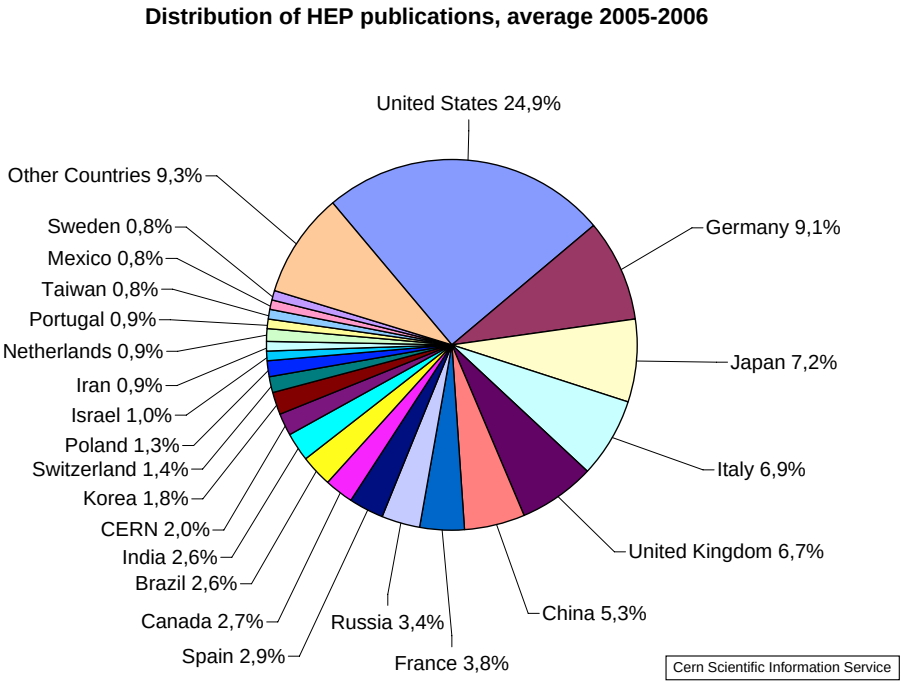


Figure 1: Contribution by country to the HEP scientific literature published in the journals spotlighted by this study. Co-authorship is taken into account on a pro-rata basis, assigning fractions of each article to the countries in which the authors are affiliated. The last slice represents contributions from countries with a share below 0.8%.

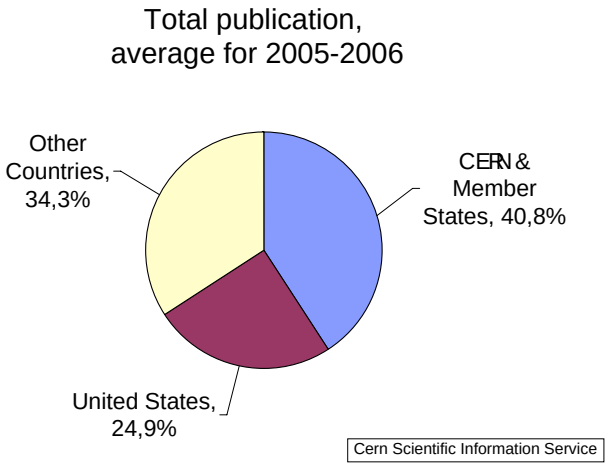


Figure 2: Contribution to the HEP scientific literature from Europe, the United States and other countries.

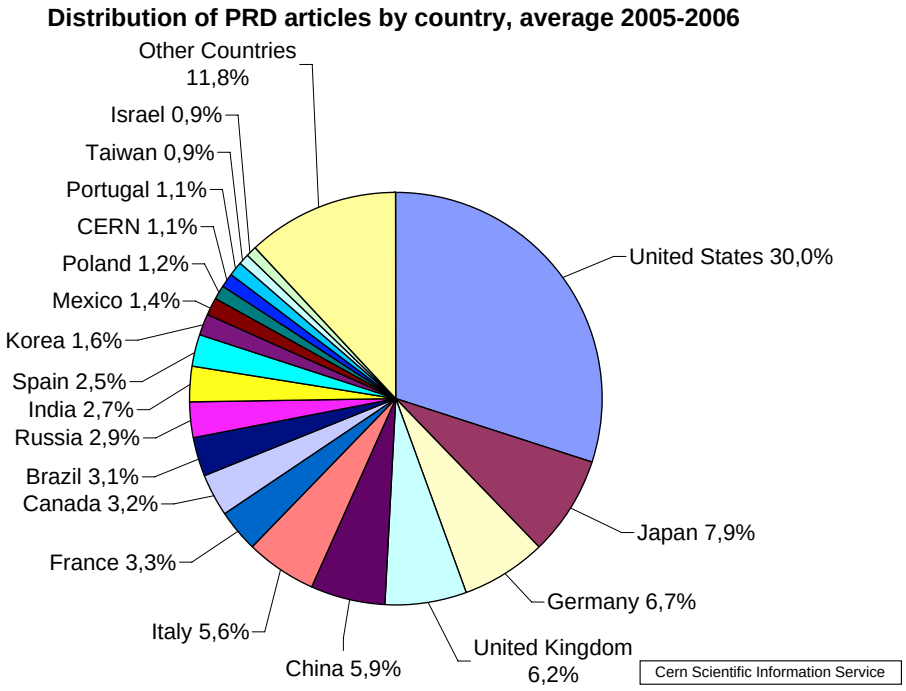


Figure 3: Contribution by country to the HEP scientific literature published in *Physical Review D* in 2005 and 2006. Co-authorship is taken into account on a pro-rata basis, assigning fractions of each article to the countries in which the authors are affiliated. The last slice represents contributions from countries with a share below 0.9%.

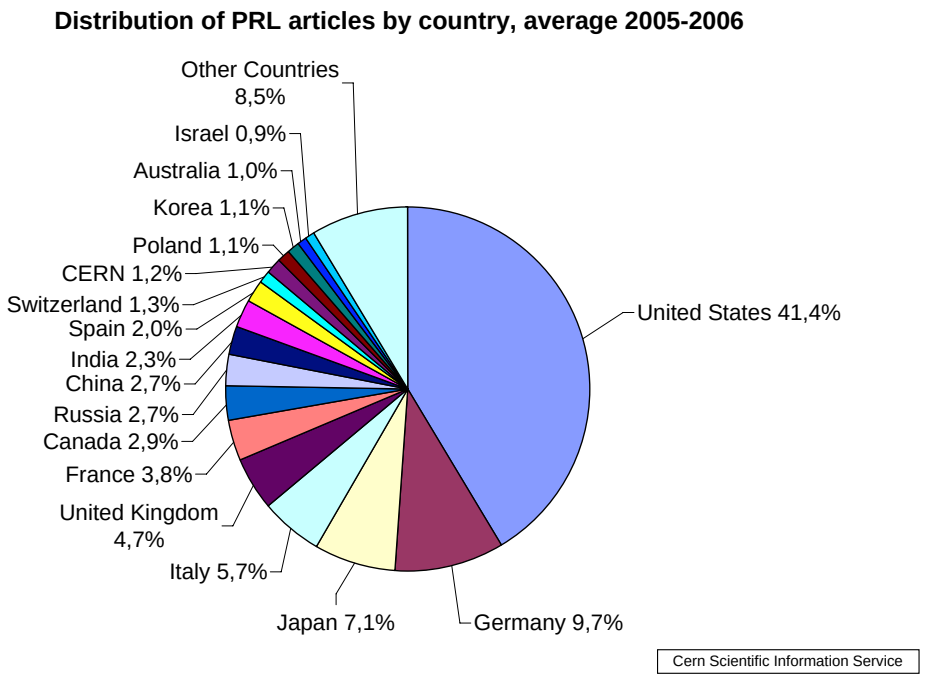


Figure 4: Contribution by country to the HEP scientific literature published in *Physical Review Letters* in 2005 and 2006. Co-authorship is taken into account on a pro-rata basis, assigning fractions of each article to the countries in which the authors are affiliated. The last slice represents contributions from countries with a share below 0.9%.

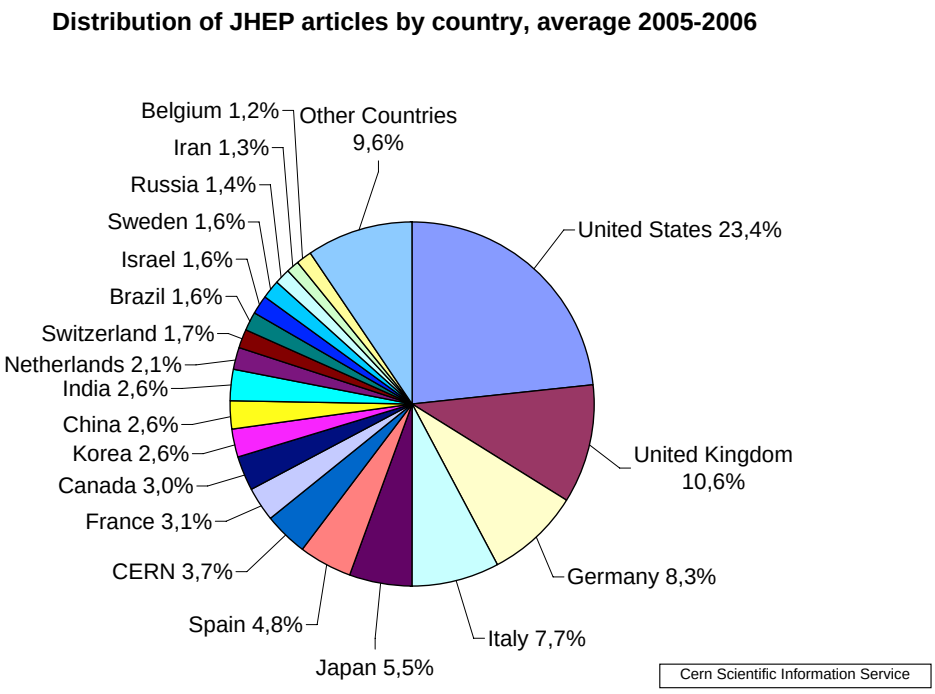


Figure 5: Contribution by country to the HEP scientific literature published in the *Journal of High Energy Physics* in 2005 and 2006. Co-authorship is taken into account on a pro-rata basis, assigning fractions of each article to the countries in which the authors are affiliated. The last slice represents contributions from countries with a share below 1.0%.

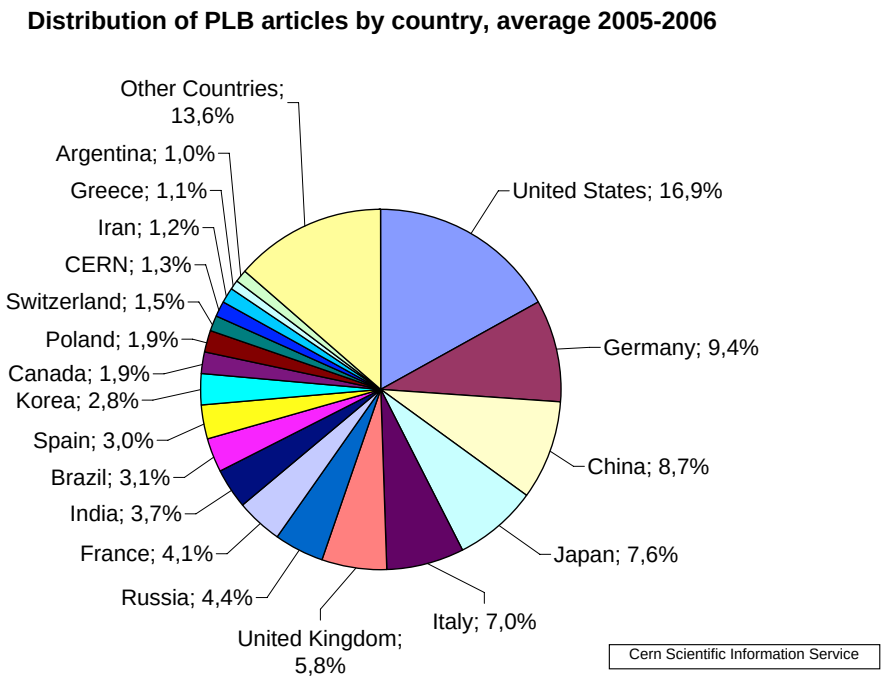


Figure 6: Contribution by country to the HEP scientific literature published in *Physics Letters B* in 2005 and 2006. Co-authorship is taken into account on a pro-rata basis, assigning fractions of each article to the countries in which the authors are affiliated. The last slice represents contributions from countries with a share below 1.0%.

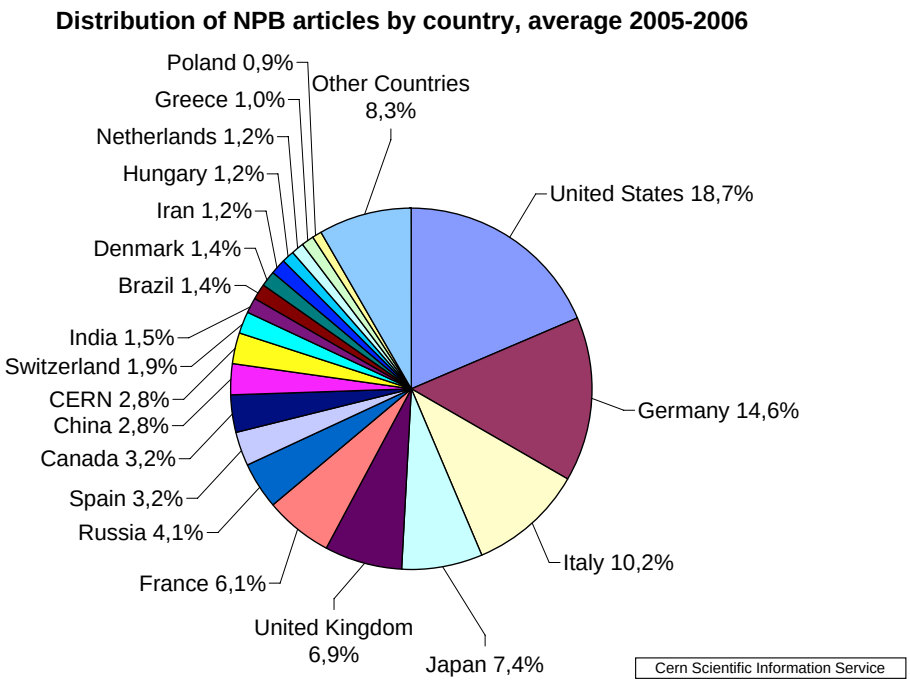


Figure 7: Contribution by country to the HEP scientific literature published in *Nuclear Physics B* in 2005 and 2006. Co-authorship is taken into account on a pro-rata basis, assigning fractions of each article to the countries in which the authors are affiliated. The last slice represents contributions from countries with a share below 0.9%.

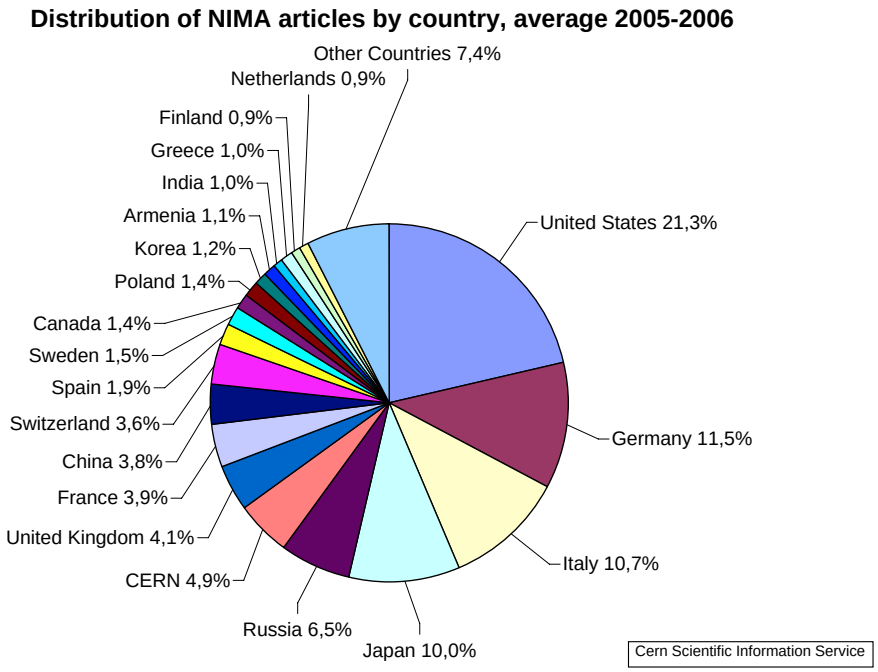


Figure 8: Contribution by country to the HEP scientific literature published in *Nuclear Instruments and Methods in Physics Research A* in 2005 and 2006. Co-authorship is taken into account on a pro-rata basis, assigning fractions of each article to the countries in which the authors are affiliated. The last slice represents contributions from countries with a share below 0.9%.

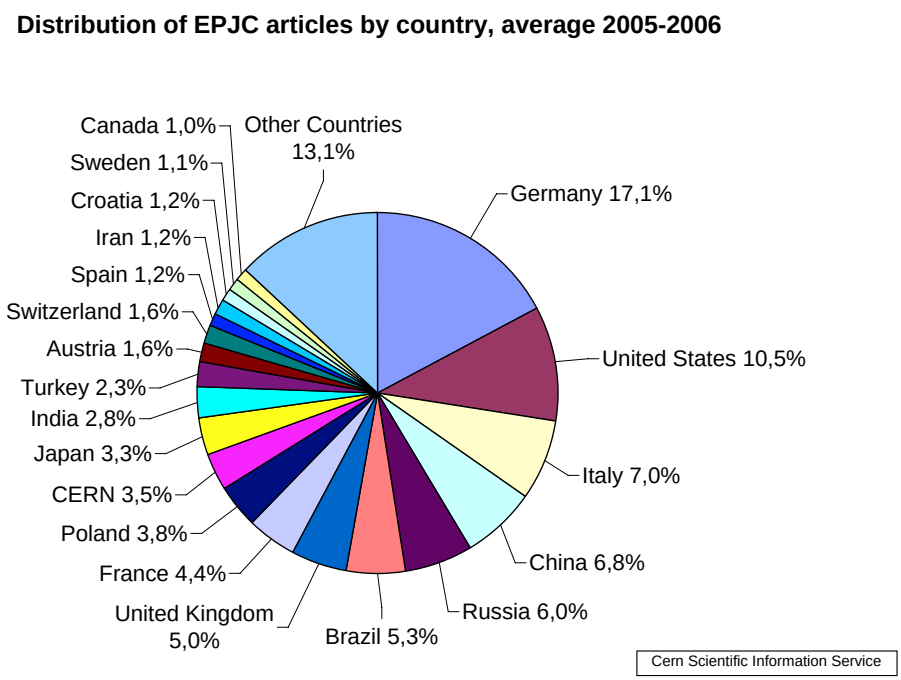
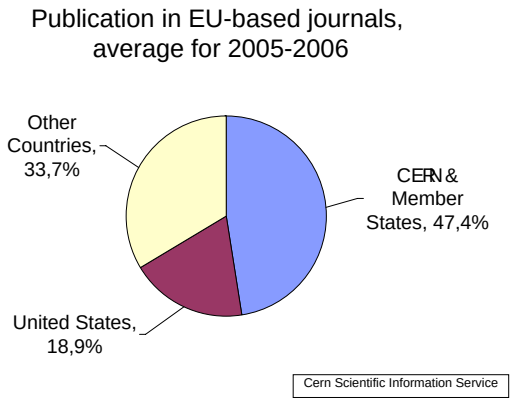


Figure 9: Contribution by country to the HEP scientific literature published in the *European Physical Journal C* in 2005 and 2006. Co-authorship is taken into account on a pro-rata basis, assigning fractions of each article to the countries in which the authors are affiliated. The last slice represents contributions from countries with a share below 1.0%.



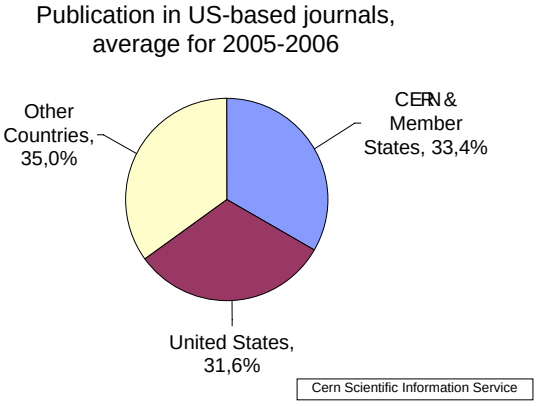


Figure 10: Contribution by European, American and other authors to journals published in Europe: *JHEP*, *Phys. Lett. B*, *Nucl. Phys. B*, *Nucl. Instr. Meth. A* and *Eur. Phys. Journal C*, and journals published in the United States: *Phys. Rev. D* and *Phys. Rev. Lett.*.

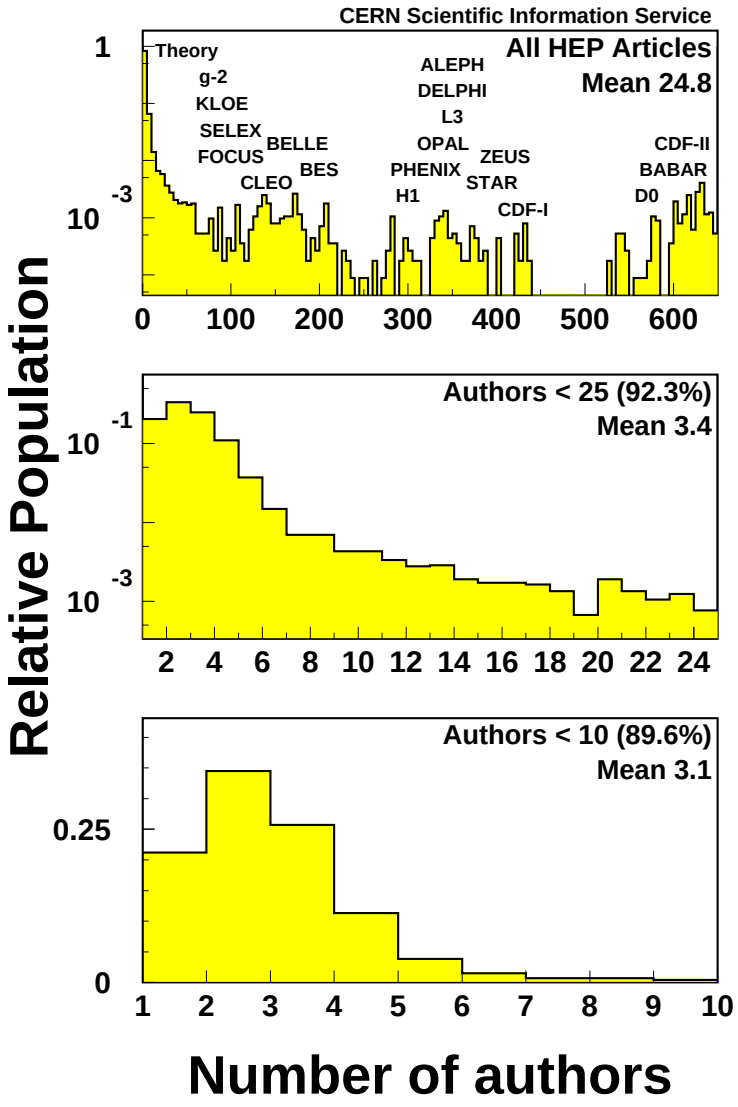
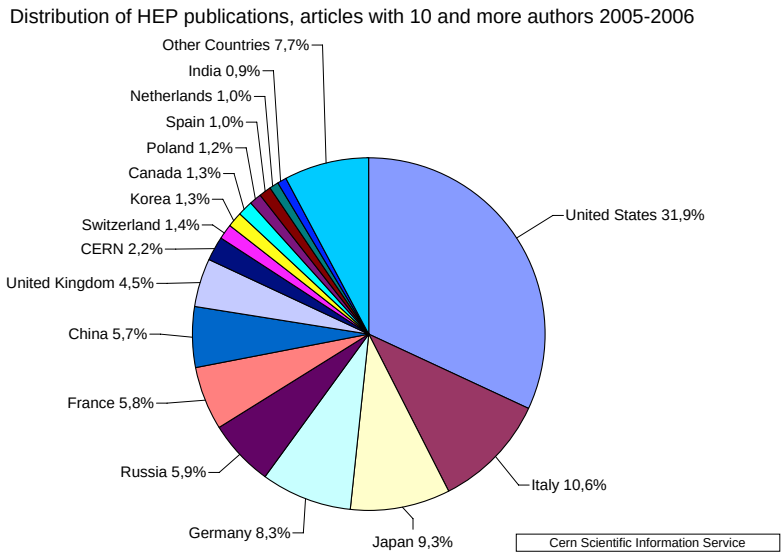


Figure 11: Distributions of the number of authors for: all HEP articles considered in this study (top), for articles with less than 25 authors (middle) and for articles with less than 10 authors (bottom). All distributions are normalised to unit area. The names of some large HEP collaborations are plotted in the top figure in correspondence with their number of authors.



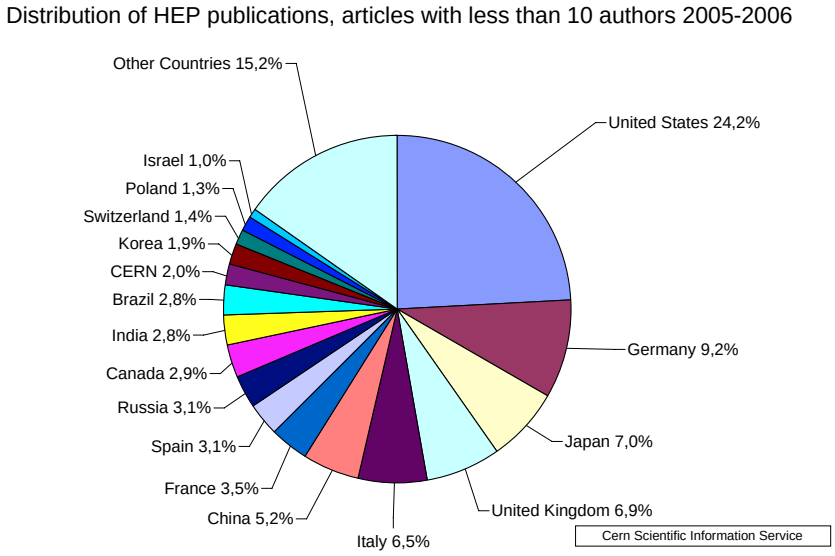


Figure 12: Contribution by country to the HEP scientific literature for the subset of articles with 10 or more authors (top) and less than 10 authors (bottoms). To a good approximation, articles with 10 or more authors are on experimental HEP and articles with less than 10 authors on theoretical HEP.

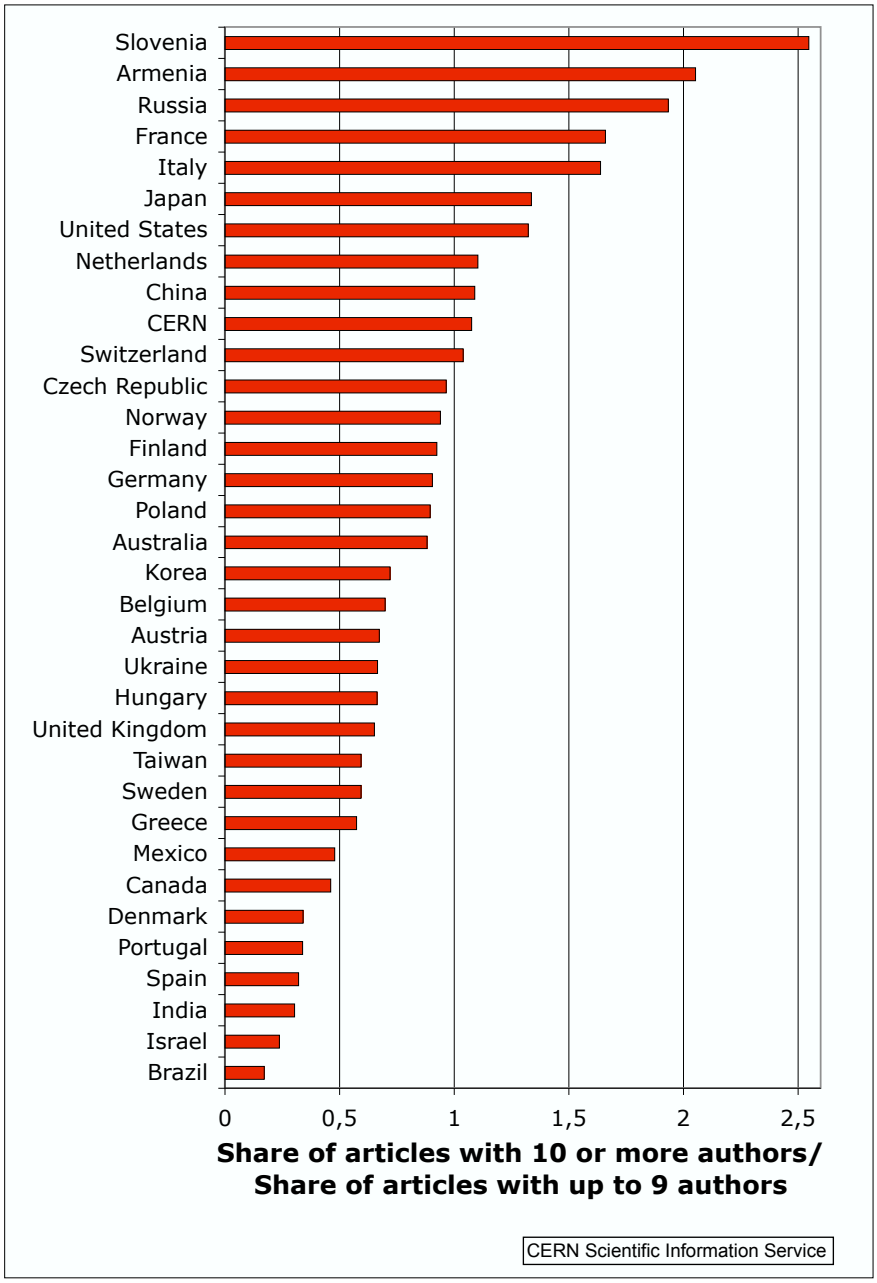


Figure 13: Ratio of the contributions of selected countries to the HEP scientific literature for the subsets of articles with 10 or more authors or less than 10 authors. To a good approximation, articles with 10 or more authors are on experimental HEP and articles with less than 10 authors on theoretical HEP.

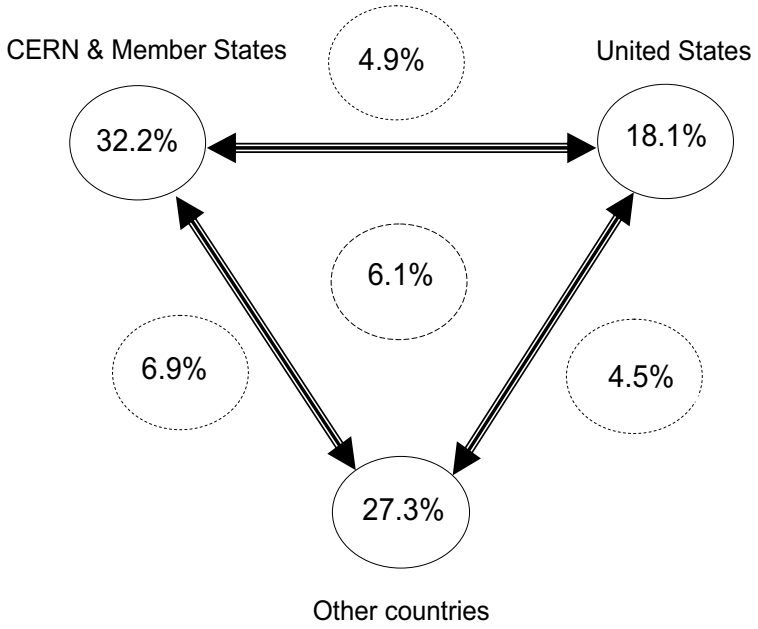


Figure 14: Collaborative patterns in HEP. Numbers in the circles at the vertexes of the triangle represent the percentages of articles produced by individual authors or authors collaborating with others within the same group of countries. Numbers in the dashed circles along the sides of the triangle represent the percentages of articles produced by collaborations of authors from countries and institutions in the two groups indicated by the neighbouring vertexes. The number in the dashed circle in the centre of the triangle represents the articles produced by collaborations spanning the three groups of countries. The plot presents results for the entire HEP production published in 2005 and 2006 in the journals spotlighted by this study.

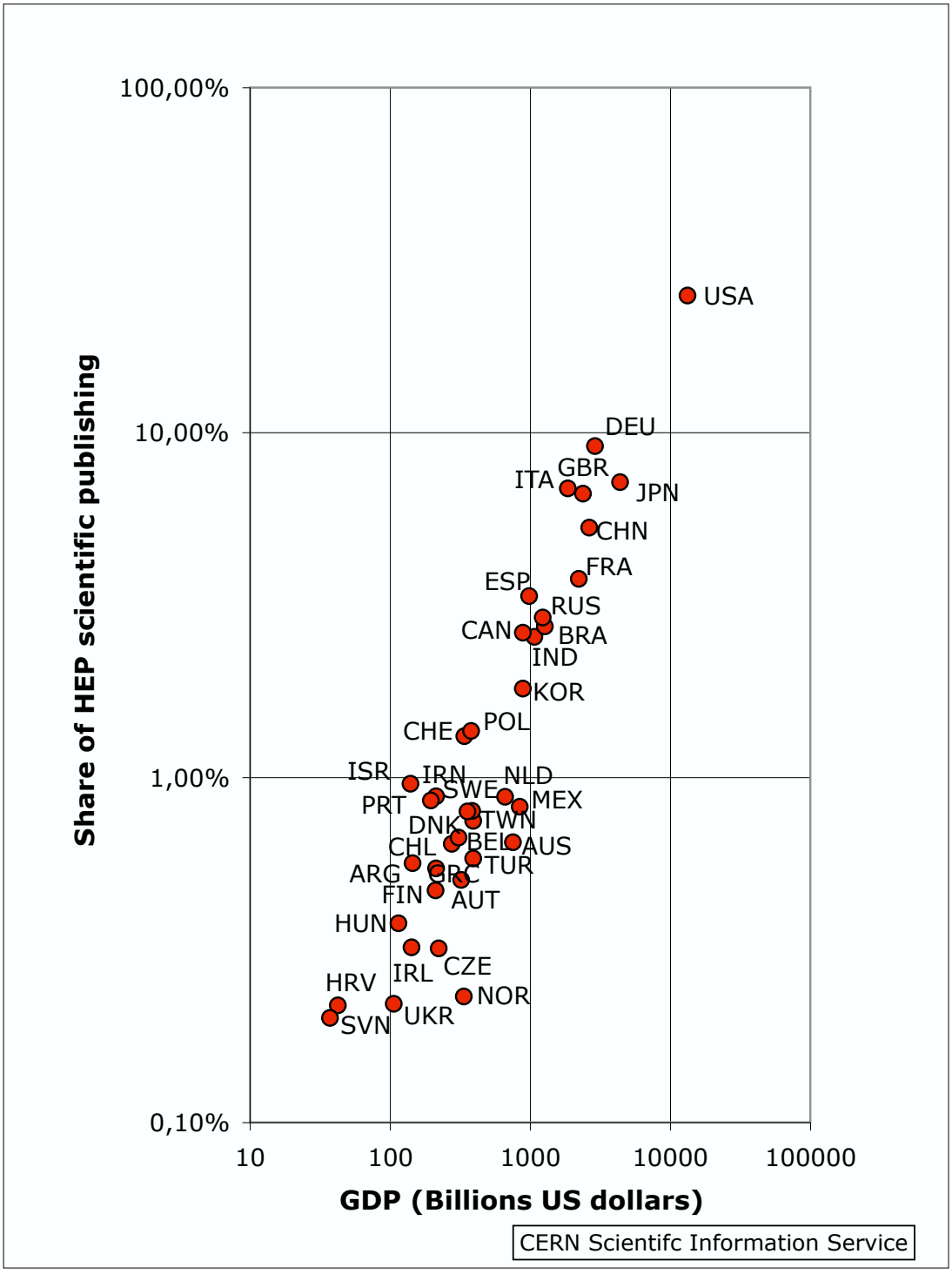
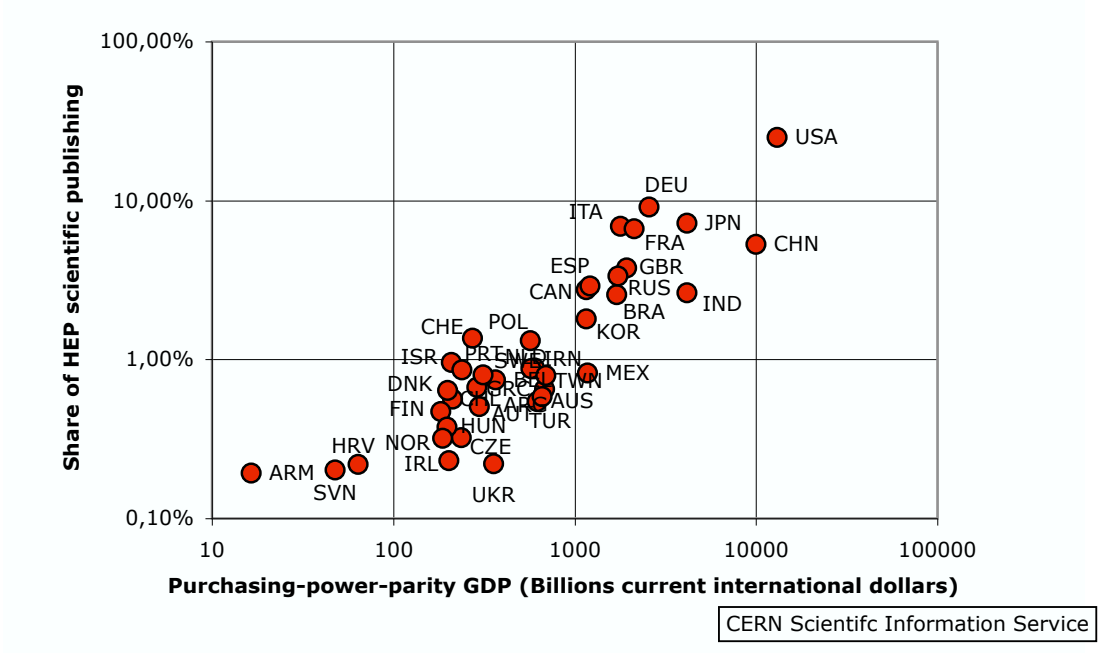


Figure 15: Share of the HEP scientific production of several country as a function of their GDP. Only countries with a share above 0.2% are shown. The two variables are found to be 95% correlated.



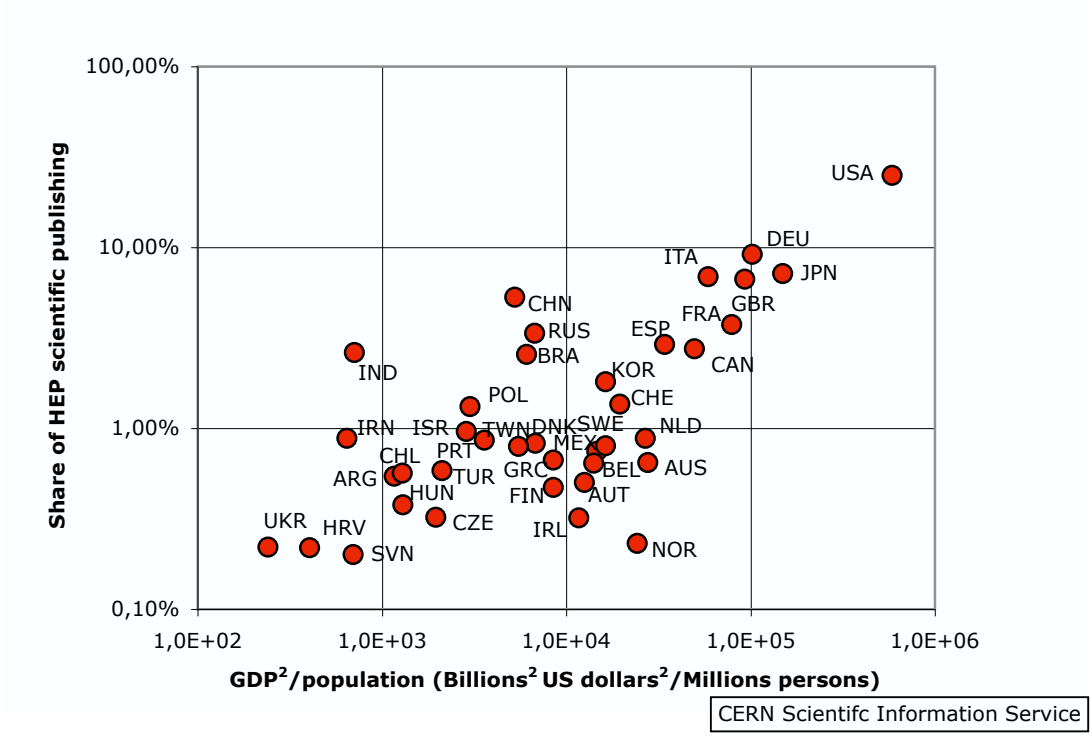


Figure 16: Share of the HEP scientific production of several countries as a function of the purchasing-power-parity GDP (top) and the squared GDP divided by the country population (bottom). Only countries with a share above 0.2% are shown.

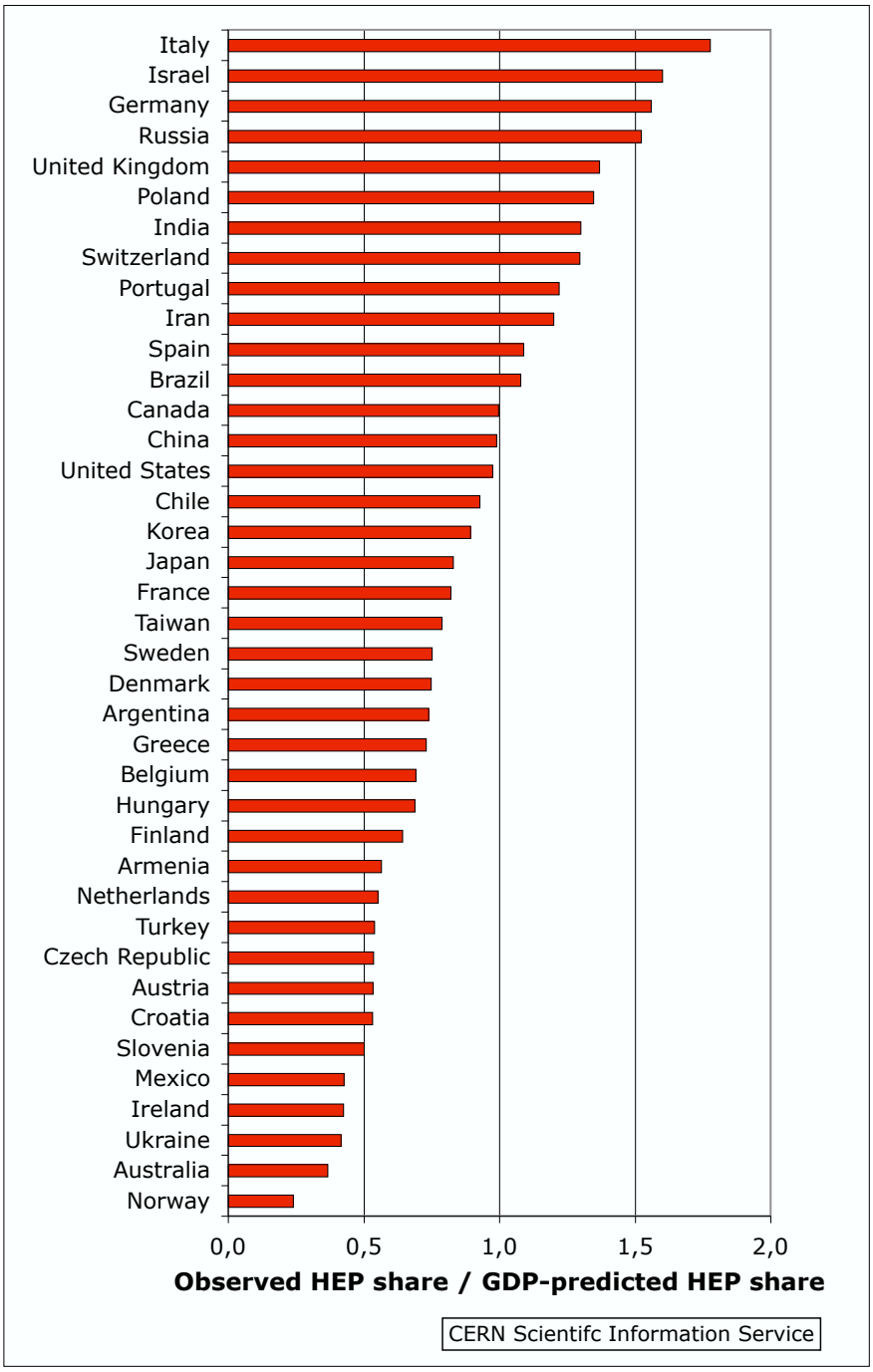


Figure 17: Ratio between the effective share of the HEP scientific production of several countries and the share expected from their GDP. Countries at the top of the plot have a long tradition of HEP research. Countries toward the bottom of the plot have relatively small HEP research communities.