A parameter to quantify dynamics of a researcher's scientific activity

S.B. Popov[1*]
[1]Sternberg Astronomical Institute,
Universitetski pr. 13, 119992 Moscow, Russia

August 8, 2005

Abstract

I propose the coefficient, t_h, and its modification N_t which in a simple way reflect dynamics of scientific activity of an individual researcher. I determine t_h as a time period (from some moment in the past till the present moment) during which papers responsible for 1/2 of the total citation index were published. Parameter N_t represents averaging of the citation index over this period: $N_t = \mathrm{C.I.}/2t_h$

1 Introduction

The problem of estimation of an impact of a scientist (or a group of them) is an actual one (see, for example, [1] and references therein). Still, in many countries, for example in Russia, citation index (C.I. hereafter) or its modifications are not widely used. Only now, especially in front of a possible reorganization in the sphere of science, russian scientists and officials start to discuss problems related to quantifying a scientific impact of individual researchers or their groups. The problem is non-trivial as many components are involved, and it is impossible to describe fairly quality of a scientist by a single parameter. The total impact can be more or less given by the C.I. (we do not discuss here such disadvantages of this parameter as dependence on research topics, influence of promotion of results, etc.). However, the structure of C.I. of a scientist (if it is mainly determined by a single paper with very high C.I., or by several of them with medium C.I., or by numerous papers with very small C.I., etc.) is lost when one one simple parameter is used. Different modifications can be suggested. Recently, Hirsch [2] proposed an interesting coefficient which supplement the standard C.I. This parameter is sensitive to the structure of C.I., i.e. it can demonstrate if the index is dominated by few papers or not. However, all these parameters do not reflect dynamics of scientific activity. Below we propose a simple estimate which can distinguish if C.I. of a scientist is due to recent or old publications, so in principle it is possible to estimate how it is probable that the scientist produce an important result in near future.

[*]E-mail: polar@sai.msu.ru

2 Characteristic time

There were many attempts to include dynamics into bibliometric studies (see, for example, the *citation age* in [1] which reflects the citation history of a given paper). It is important to determine a characteristic time interval; not arbitrary, but individually for each scientist. For example, one can think about a minimum time (min Δt) in a scientific career of a person, when papers responsible for 1/2 of the total C.I. were published (obviously, for scientists who did the main contribution in one paper or in a set of papers published during a short time min Δt is short, vise versa for those who continuosly published papers of the same level min Δt is comparable with the duration of the career). If one adds to this min Δt another parameter - time interval separating the the present moment t_0 from the end of the period responsible for min Δt - then we have a rough figure of scientific activity of a scientists in time. However, I think that a better parameter can be defined.

Here I discuss a simple way to estimate a characteristic applicable to individual scientists. Up to my knowledge such a parameter was not discussed before.

The idea is to define some characteristic time which can demonstrate how long ago a scientist published papers which give the main contribution to the C.I. I propose the parameter t_h which is defined as follows. It is the time (from the present moment towards the past) during which papers that are responsible for 1/2 of the total C.I. were published. Let me examplify it.

Imagine three scientists (see Fig.1). All started careers simultaneously. At the present moment all three have the same C.I.=5000. One published in 1965 a paper with C.I.=5000, and nothing after that. For him $t_h = 40$ years. The second published a paper with C.I.=2500 in 1965 and another one with the same C.I. in 1975. For him we obtain $t_h = 30$ years. The third one also had published in 1965 a top-cited paper with C.I.=1000, and then every year published a papers all of which now have C.I.=100. For him $t_h = 25$ years as 1/2 of his C.I. is due to papers published after 1980.

The parameter t_h alone is not a very useful thing as it says nothing about the total impact. But it can be useful to distinguish researchers who's activity is not in the far past. Clearly, even for the same total C.I. t_h is shorter for those who published papers with large impact later. Especially, t_h can be useful when both young and more senior scientists are under consideration. It appears indeed capable to ideally complement the standard C.I. or Hirsch's parameter h.

It is possible to modify t_h to include information about the total C.I. And in the following section I show a possible way to do it.

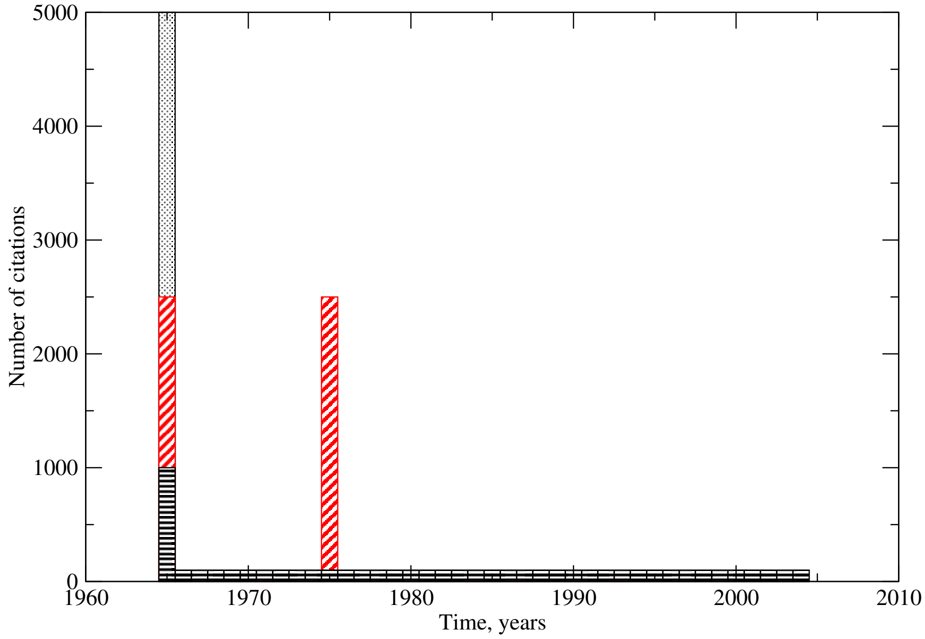

Figure 1: A simple illustration of scientific activity of three scientists with the same total C.I., but with different distribution of important papers over time.

3 Average activity over the characteristic time

After we determine t_h we know a characteristic time scale of scientific activity of a researcher. Now what we can do is to average its C.I. (or better 1/2 of C.I. as t_h is related to half of the total index, and letter h comes from *half*) ovet t_h. We define

$$N_t = \mathrm{C.I.}/2t_h.$$

For the three scientists in the example above $N_t = 62.5$, 83.3, and 100 correspondently. For the same total C.I. values of N_t are different demonstrating the fact that the first one was unactive for a long time, and the period of activity of the third one is closer to the present moment than for the rest two researchers. For the same C.I. N_t can be different up to a factor of a few (or even by an order of magnitude) if persons have significantly different histories of scientific activity.

4 Conclusions

I presented a simple etimate t_h of a time scale which demonstrates dynamics of scientific activity of scientists. Also the parameter $N_t = \mathrm{C.I.}/2t_h$ was proposed as a compromise between integral and dynamical characteristics of scientific impact. In my opinion t_h can be a good additional parameter to the standard C.I. value.

Acknowledgments

I want to thank Prof. J. Hirsch for comments on the idea of the coefficient t_h, and to participants of the project Elementy.Ru for discussion.

References

[1] Redner S., 2004, physics/0407137

[2] Hirsch J.E., 2005, physics/0508025