THE ASTRONOMICAL COMMUNITY IN THE NETHERLANDS

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Abstract

A list has been compiled for essentially all scientific staff at Netherlands astronomical institutes with their first author citations in the period 1986 to 1992. In addition for each person for the year 1992 the number of cited publications has been compiled, their earliest, most frequently and most recent cited paper. Various conclusions can be drawn fron this: (1) the earliest cited paper usually is from near the year of the Ph.D.; (2) the most recent cited (first author) paper is usually less than 5 years old; (3) a personal high citation rate is generally a result of a reasonable number citations to most of ones papers rather than due to a single, highly cited paper; (4) Netherlands astronomy is most visible in observational studies, especially concerning stars, interstellar medium and our own and other galaxies and using in particular UV, IR and optical facilities. Comparison in mean citation rates determined in other studies are also made, resulting in an excellent score for the Netherlands astronomical community.

1 Introduction.

On behalf of the Foundation for Astronomical Research in the Netherlands (NFRA or ASTRON), an analysis is currently being carried out, where citation rates of articles published at Netherlands institutes in the 80's are collected and related to in particular the use of the observing facilities offered by the Foundation. This traces the impact of *papers*. In this article I intend to do an analysis for the current *staff* of Netherlands institutes, where I will use their total citation rates regardless of where they worked when the paper was written. This also allows a comparison with astronomical communities in a few other countries by doing studies similar to ones that are available in the literature. In that sense it is also a follow-up of the article, where I compared the funding and publication/citation data for OECD countries (van der Kruit, 1994).

The following uses citation statistics of persons. There is considerable debate on the use of such figures. Part of this focusses on the reliability with which it measures scientific standing (supposing that that is what one tries to measure). It certainly would be a major mistake to take citation numbers at face value; however, experience shows that it does in a general sense correlate with what one would assign intuatively as a person's scientific standing, although not absolutely, and counter-examples can easily be produced. Abt (1993) has made the point that citation counts measure the usefulness and not necessarily the importance of papers. Jaschek (1992) uses the term 'visibility', when he studied citation rates in a few West-European countries. In a recent publication, Plomp (1993) argues that citations are a useful indicator of the extent to which publications contribute to the progress of science and denotes it in short by 'quality'. He compares it to scores in goals by soccer teams of which the ranking also would indicate the relative quality of these teams. This seems to imply that quality (or impact) is in his opinion *by definition* a measure of the contribution to science's progress and quality is therefore what citation scores measure. Although there is something to be said for this, I prefer to use the more value-free 'visibility' or 'impact' and will refrain from the use of 'quality'.

A second reason for people's suspicion is that the numbers can be used to compare countries, institutions or even persons and use that to convince funding agencies or the general public that one such entity is ahead of others in some race (not just to secure as large as possible a share of the funds available, but also simply for being recognized as the best). Part of this is due to the fact that quality and visibility are confused; at least, since often the implication of quality is not what Plomp means, but rather a measure of who does better science (whatever that is). Undeniably, citation rankings do have an effect, such as for example the yearly hit-lists of the 'best' (that is what one reads in newspapers) economists or sociologists in the Netherlands. I have witnessed the excitement when in a recent article in *Science* (**260**, 1739; 1993), the Chemistry Department of Groningen university ended up as 17^{th} in 'Europe's Top 25'. In my judgement, the excitement was at least in part not just due to the fact that it came in among the European top 25, but also that it was ahead of other Chemistry Departments at Netherlands universities. That *Science* article actually used the word 'elite'. Of course, persons or institutions don't mind being cited as being high up on the list. Almost every person, that I talked to and became aware of the existence of the list of citations used here, was keen on having a look at it.

In the following it is unavoidable that comparisons are being made. I would stress that I am only trying to established visibility and any interpretation of quality (in whatever sense) is not implied.

2 The dataset.

I started out with a list of citations over the years 1986 to 1991, that was prepared by H.C. Spruit. It was kindly made available to me through T. de Jong. Spruit used the Science Citation Index of the Institute for Scientific Information for these years to count citations for a set of astronomers working at Netherlands institutes and astronomers of Netherlands nationality working abroad. These concern only so-called first author counts, so only based on citations of those articles on which the person is the first author. There was no attempt to correct for self-citation.

For my purposes I took only those persons that work at Netherlands institutes as follows:

- All permanent scientific staff members regardless of their nationality. I generally took the situation for the middle of 1993, but did include a few persons that have accepted permanent positions at that time, even if they had not actually arrived. There are 4 catagories, namely HL (Hoogleraar or full professor), UHD (Universitair hoofddocent; equivalent to associate professor), UD (Universitair docent; equivalent to assistant professor) and other scientific personel (with specific duties, but usually teaching and research not as the primary ones).

- All temporary scientific staff of at least postdoc level, but only if they had the Netherlands nationality.

- Those retired staff members (emeriti) that are still active. The criterion generally was inclusion in the staff listings in the annual reports of their institutes or their staff lists as compiled by the Netherlands Committee for Astronomy (NCA). Because of his standing, I did retain Jan Oort in the listing although he had died before mid-1993; in spite of his age of about 90 in the period considered and the fact that after some time people start to not list original references, he still ends among the 5 most highly cited persons over these years. Long term guests (persons working at an institute, but not actually employed) were also included.

- Ph.D. students were excluded.

For this purpose I had to add some names to the list of Spruit. Also some persons appeared in my judgement surprisingly different from my expectation. I checked these and found a few cases where corrections for persons with similar names were obvious and necessary or where a misspelling of the name had occurred. P.D. Barthel has produced a similar list of the staff members of the Kapteyn Institute (Groningen) for the years 1991 and 1992. His independent listings often show differences up to about 5%, resulting probably from how and to what extent corrections were attempted for misspellings and for authors with identical names. So one should keep in mind, that the accuracy is probably not much better than a few %. The list of 103 persons contains only 4 women.

I added for each person the following data:

- Citations for 1992.

- Number of publications referred to in 1991 (not 1992, since the cumulative citation index for 1992 was not yet available).

- The year and number of citations for the oldest and the most recent publication cited in 1991.

- The reference and number of citations for the most frequently cited paper in 1991 (if two had the same number I took the oldest publication). Here I did not include review papers or books. Later I looked up these references and noted the number of co-authors, instrument used (if any) and the general astronomical area. Remember that all information used concerns *first author* publications only.

- The year in which the Ph.D. degree was obtained.

- The current position held at their institute.

The aim of this was to determine the length of the active period, the area in which a person has his/her largest visibility and the facilities that were used. In the process I noted the well recognized danger of using a single year. For example, the number of citations in any year may be strongly influenced by the publication of a symposium. Often a paper at a conference recieves many citations for a very limited time. E.g. one person had an average of about 60 citations per year over the period 1986–1991. But in 1992 an IAU Symposium had just been published, which yielded 38 citations and his total for that year jumped up by almost that number.

Sometimes it helps to have written a book. H.C. van de Hulst's classic book on scattering of light by small particles yields him usually 160 to 200 citations per year; S.R. Pottasch's book on planetary nebulae of order 30 to 40 citations per year; but C. de Jager's book on luminous stars only a few per year. It does not help to edit a conference symposium, because citations get credited to the authors of the articles in it.

3 Profile of the astronomical community in the Netherlands.

Before looking at details I furthermore assigned subgroups to the astronomers following those of Trimble (1993a, 1993b), which concerns American and British astronomers selected from the AAS or RAS directory. Since these directories contain persons that do not live in the USA, respectively UK, I will not refer to these as USA or UK samples, but as the AAS and RAS samples. These subgroups are the following:

- *Chronological cohorts.* Trimble used for this the year of the earliest cited paper and found that, quite typically, this was the year of the Ph.D. dissertation. I actually used the year of the Ph.D., but we will see below that for the Netherlands sample the two years correlate very well.
- *Employers.* Since ours are selected as such, the present sample concerns only her categories U (universities), O (observatories), I (research institutes) and L (laboratories).
- *Activity.* This is either 'theory', 'observation' or 'instruments'.
- *Research area.* Virginia Trimble informs me that the area 'dynamics' concerns the full range of the AAS division of dynamical astronomy, very little of which is extragalactic. There is no significant component of this in Netherlands astronomy and all workers on galactic dynamics are grouped under 'galaxies'. Also I assumed 'high-energy astrophysics' to concern AGN's, quasars, etc. and not compact stellar objects (these are under 'stars') . What remains then are the research area's: 'sun', 'solar system', 'stars', 'Milky Way + ISM', 'galaxies', 'HEAP' and 'cosmology'.
- *Wavelength region.* As Trimble this is 'X- and γ-ray', 'optical', 'infrared + ultraviolet', and 'radio'.

The first excercise then is to look at the distribution of chronologocal cohorts. This (and those for the categories U+O/I/L for the AAS and RAS astronomers) is given in table 1 (These are 100 persons, because in the sample of 103 three never obtained a Ph.D.).

From the distribution we see that there are minor differences between the countries. If expressed in the number per interval of 1 year, the peak comes in the cohort 1968-74, which is the well-known problem of the uneveness in the age distribution with a peak at current ages mid-forties to mid-fifties, which holds for most countries. The median year of Ph.D. are 1976 (NL), 1977 (AAS) and 1975 (RAS) and the upper quartiles 1983 (NL), 1983 (AAS) and 1985

Table 1: Distribution of chronological cohorts.

year of Ph.D.	NL	%	AAS	%	RAS	%
1928-45	1	1	5	2	3	2
1946-56	4	4	14	5	12	8
1957-67	18	18	37	12	25	17
1968-74	25	25	70	23	32	22
1975-81	24	24	92	30	26	18
1982-91	28	28	84	28	50	34
total	100		303		148	

Table 2: Cohorts and type of employment.

year of Ph.D.	HL	U(H)D	pd	other	emer.
1928-45					1
1946-56					4
1957-67	5	6		1	6
1968-74	13	9		1	2
1975-81	4	13	3	4	
1982-91	3	12	7	6	
total	25	40	10	12	13

(RAS). We have to be careful here to keep in mind that degrees in different countries may not be comparable. In the Netherlands before the seventies persons were obtaining their Ph.D.'s after a much larger piece of work than nowadays. However my impression is that from the seventies onwards persons were obtaining their Ph.D.'s in the three countries at much the same ages.

Table 2 splits this information for the NL community out into the type of employment. Of the 48 astronomers in the cohorts 1957-74, 23 (including 5 retired persons) have the professor title (48%) and in the following cohort this is 4 out of 17 (27%). This means for the 1957-74 cohorts, that once one had secured a tenured research position, there was a roughly 50% chance of obtaining a professorship. If this were to happen to the 32 tenured astronomers in the 1975-91 cohorts then 9 professor appointments in addition to the 7 already made would be required and that is possible, even if some professors were to be recruited from outside this group.

Next we look at the distribution of citations per year. Tables 3 and 4 give this information as a function of type of employment, respectively for the periods 1986-92 and 1990-92. The total numbers are somewhat different from the previous tables, because some persons never obtained a Ph.D. and did not end up in tables 1 and 2.

There is a crude relation between the citation rate (visibility) and type of employment, although there are also clear exceptions. These reflect the fact that promotion from UD to UHD or from UHD to professor depends on more factors, such as a vacant position or judgement concerning other qualifications. Conversely, some professors have moved into demanding man-

Table 3: Distribution of citations 1986–1992.

citations	log(cits/yr)	HL	UHD	UD	pd	other	emer.	total
1110-1758	2.2-2.4						1	1
701-1109	2.0-2.4	4			1		1	6
442-700	1.8-2.0	7		4			2	13
279-441	1.6-1.8	5	3		1	1	1	11
176-278	1.4-1.6	5	5	5	2	1	1	19
111-175	1.2-1.4	3	6	2	2	2	3	18
71-110	1.0-1.2	2	3		2	3	1	11
45-70	0.8-1.0		1	1	1	2	1	6
28-44	0.6-0.8		1	2				3
18-27	0.4-0.6			1	1	1		3
12-17	0.2-0.4	1	1			1	1	4
7-11	0.0-0.2			1			1	2
< 7	< 0.0		1	4			1	6
Total		27	21	20	10	11	14	103

agerial jobs and are not active any longer in research, while others seldom appear as first author on a paper. The difference between the 1986-92 and 1990-92 numbers partly reflect the fact that relatively young researchers are still in the stage of increasing their annual citation rates.

Before making comparisons of citation rates of subgroups, etc., I will first look at the distribution of citations per paper. It is undoubtledly the case that once an article gets cited, the yearly citation rate depends on the field of astronomy. For example, papers on solar astronomy could easily get lower numbers of citations than on, say, quasar research. Table 5 collects the results, where for the 1991 data the total citations in various subgroups of persons are divided by the number of articles referred to. References to textbooks have been excluded there. Solar and solar system astronomers score significantly lower than extragalactic researchers. This trend is noted by Trimble for AAS and RAS samples as well.

It is possible to address this in a different way by examining specialised journals relative to others. Table 6 gives some information. There the journals are compared in two ways. One measure is the so-called impact factor determined in the Citation Index. Table 6 gives the mean impact factor for the years 1986–1990. The second is the mean citation rate per paper, taken from the study of Schubert *et al.* (see also van der Kruit, 1994, table 3). For *Nature* no figures are known for astronomy articles and the impact factor is that for the journal as a whole. Both are very similarly determined. The data seem to confirm that solar, solar system and space instrumentation astronomers are likely to receive fewer citations than those in other fields (see also table 12 below). This might explain a large fraction of the variation in table 5. The last column of table 6 is the distribution of each person's most frequently cited paper in 1991; this is for later use in this article.

Now I will look at the more detailed information that was collected for 1991. First, in table 7, I give the distribution of the astronomers over their number of papers (excluding books) cited in 1991 (upper part) and the number of citations received in 1991 to those papers, as a function

Table 4: Distribution of citations 1990–1992.

citations	log(cits/yr)	HL	UHD	UD	pd	other	emer.	total
475-753	2.2-2.4						1	1
300-474	2.0-2.2	3			1		1	5
189-299	1.8-2.0	5	1	3			2	11
119-188	1.6-1.8	10	4	2	2	1	1	20
75-118	1.4-1.6	2	4	2	2	2	1	13
47-74	1.2-1.4	3	5	3	3	2	3	19
30-46	1.0-1.2	2	3	2	1	2	1	11
18-29	0.8-1.0	1			1	2	1	5
11-17	0.6-0.8		2	2		1		5
7-10	0.4-0.6		1	1		1	1	4
4-6	0.2-0.4	1		1				2
3	0.0-0.2			1			1	2
< 3	< 0.0		1	3			1	5
Total		27	21	20	10	11	14	103

of the year of the Ph.D.

There is nothing very remarkable in this. The youngest cohort had less chance to built up a publications list, but the distribution is not markedly different from the second youngest cohort (upper part of table 7). The youngest cohort has on average more citations in 1991, presumably because a larger fraction of their papers should be closer to the year of their citation peaks. Schubert *et al.* (1989) quote a citation peak at about 2 to 3 years after publication, while Abt (1981) finds for 1961 astronomical papers that the peak occurs after about 5 years. As a check on this I followed the citation histories of the papers of which I myself was a (co-)author. Relatively frequently and relatively infrequently cited papers showed the same characteristic of reaching the peak after 5 ± 1 years. The frequently cited papers had higher peaks and then settled at a more or less constant level after a decline during 5 years or so. The average Netherlands astronomer had in 1991 about 14 (first-author) papers cited and these yielded almost 3 citations per paper.

Trimble has used the year of publication of the oldest cited paper as an indication of the year of the Ph.D., since she infers that this usually concerns the thesis work itself. Table 8 lists the difference in the year of publication of the oldest cited paper in 1991 and that of the thesis as a function of the year of Ph.D. There is indeed a sharp peak in the years around the Ph.D.; often the oldest cited paper predates the submission of the thesis (especially the older cohorts). This reflects the fact that often part of the thesis research has already been published and this was even more the case in the older cohorts. In any case, it shows that even after 10 years or more one keeps getting citations to one's earliest work and this confirms Trimble's approach of estimating the year of the Ph.D.

Table 9 looks at the years of the most recent and most frequently cited papers (again books have been excluded). The column headings are the years of the Ph.D. From the top part of table 9 we see that for all age cohorts the most recent cited paper has usually been published in the last 5 years, indicating that most Netherlands astronomers remain active in research and produce citable publications with them as first authors. For the older cohorts a larger fraction

Table 5: Citations per article in various subgroups.

subgroup	citations	publications	cits/publ.
Theory	483	196	2.5
Observations	3313	1090	3.0
Instruments	118	51	2.3
Sun	156	76	2.1
Solar system	189	93	2.0
Stars	1264	474	2.7
MW+ISM	771	278	2.8
Galaxies	1013	330	3.1
HEAP	261	76	3.4
Cosmology	85	28	3.0
All	3914	1337	2.9

of the most recent, cited papers actually is a review paper, but this is not surprising, as older astronomers are more likely to be invited to give reviews and often are less likely to become first author on a research paper.

The lower part of table 9 does the same thing for the most frequently cited paper, but now review papers have been excluded. The majority of these are not coincident with the year of the Ph.D. (these usually must have been past the peak in their citation rate by 1991). For the cohort that received their Ph.D. in the seventies (and that usually now hold senior positions at their institutes) most persons published their currently most cited paper between mid-seventies and mid-eighties, so on average about 5 years after their Ph.D. degree and often in the first years after a postdoc period, when they were either tenured or at least tenure track.

Referring back to table 6, I will now discuss the question of the journal in which the most frequently cited paper has appeared. The final column of that table presents that information. Slightly more than half of these have appeared in the 'natural' journal for Netherlands astronomers, namely the *Bulletin of the Astronomical Institutes of the Netherlands* (B.A.N.), which merged in 1969 with other European journals in *Astronomy and Astrophysics.* Still more than one in five appeared in the major American journals (Ap.J. and Astron.J.). This is in small part due to the fact that some current staff members are foreign and were recruited after they had established themselves already. Although for about 40% there is only one author, the single author papers have almost all appeared in A & A (or B.A.N.) or specialised journals. For papers in these journals, the median number of authors in this sample of papers is 2.0, while for Ap.J. and A.J. it is 3.5. Papers often end up in American journals when co-authors are from the USA and reluctant to publish in a European journal. Papers in American journals are likely to be cited more often (see table 6) and this may explain, why about 23% of the most frequently cited papers are published in the USA, while an examination of the annual publication lists of the institutes and the Schubert *et al.* data (see van der Kruit, 1994) shows that a significantly smaller fraction (more like 13%) of all Netherlands papers are published there.

A further point to note is that the year of publication of the most frequently cited paper in many cases is not in the most recent years, so these papers in most cases must be even over their citation peaks. In fact, only 10 were published in 1988 (and 3 in 1989 and 1990) and these

Table 6: Astronomical journals.

Journal	impact factor	citations per paper	most frequently cited papers
Nature	16.7	-	7
Ap. J.	3.51	8.1	19
M.N.R.A.S.	2.55	5.0	2
Astron. J.	2.24	4.7	4
Icarus	-	4.2	-
Astron. Astrophys.	2.13	3.8	40
Space Sci. Rev.	1.63	3.7	2
Solar Physics	1.20	3.2	3
B.A.N.	-	-	9
Others	$<$ 1.5	$<$ 3	12

must be near their citation peak. So, 86% of these most frequently cited papers should in 1991 have been already over their citation peak.

It is of considerable interest to see which facilities were used in the most frequently cited paper. In a sense this determines with what facility the astronomer has achieved his highest visibility. This has been tabulated in table 10. First one sees that about one third are papers listed as 'theory/interpretation'; that is to say, papers that are either purely theoretical or are analyses that do not actually present new observational data. Of course, many of the other papers equally well contain modellings or other analyses of the data in addition to presenting these data. It may suggest that what survives longer is the science actually done with the data and not the observational information itself.

We then see that the WSRT and ESO are the facilities that have most often provided the data for the most frequently cited paper. Dwingeloo also still provides such papers. UKIRT has made a small contribution, but La Palma and the JCMT are probably too recent facilities to contribute (the first major papers based on the WHT and the JCMT have appeared in the literature only during the last 2 years prior to 1991). Other (non-NL) facilities (Palomar and Kitt Peak in the optical and the VLA in radio) occur as well; in about half the cases this is by astronomers that at the time of the writing of the paper were employed elsewhere, but in the other half employed in the Netherlands. Of the astronomers in table 10, 35 have produced their most frequently cited paper with a theoretical or interpretative study, 14 with data from a space facility, 20 using optical and 19 with radio data.

4 Comparison to other samples.

In the first place I will carry out a similar analysis for the Netherlands community as has been published by Trimble (1993a,b) for the AAS and the RAS samples. She had two categories that I will due to small numbers not try to reproduce for the NL, namely price-winners and officers. Her so-called random sample was selected from the directories of the national professional societies and should be comparable to the NL sample, at least if I restrict myself to the categories

Table 7: Cited papers and citations 1991.

Cited papers						
Year of Ph.D.	0-10	11-20	21-30	31-40	> 40	mean
≤ 1960		1			3	42
1961-70	11	12	1	1	1	15
1970-80	24	11	2	2	1	12
1981-90	19	7	3	1		12
Total	54	31	6	4	5	14
Citations						
	0-29	30-59	60-89	90-119	≥ 120	mean
≤ 1960		1	1	2		77
1961-70	15	5	3	3		35
1971-80	25	7	6	1	1	32
1981-90	16	6	7		1	39
Total	56	19	17	6	2	37

Table 8: Year of oldest cited paper minus year of Ph.D. as a function of year of Ph.D.

Difference	≤ 60	61-70	71-80	81-90	total
-9 to -7	1	2		1	4
-6 to -4	1	5	2	3	11
-3 to -1	1	5	12	13	31
0 to 2	1	7	14	11	33
3 to 5	2	1	1	1	5
6 to 8	1	1	4		6
9 to 11		1	3		4
12 to 14			1		1
15 to 17		1	2		3

U+O/I/L in her samples. With reference to table 1, I note that the RAS sample is 1.5 times and the AAS sample 3 times as large as the NL sample (which cannot be enlarged).

Table 11 lists the citation rates by sub-group. It should be recalled that the Netherlands citation data I used are not corrected for self-citation, while the AAS and RAS numbers are. Trimble (1986) found a self-citation percentage of about 15%, but that is in a very strict sense, namely citations where the citing and cited paper have at least one author in common. In discussions based on first author counts one should take self-citation to mean that the citing and cited paper have the same first (or sole) author. Abt (1980) has determined that percentage as about 6.5%, and I have reduced the NL numbers by that amount.

The category 'all' is not very usefull, as it concerns samples that are not really comparable. The other 4 in the top-panel are better. The last two are meant to look for effects of possible different selection bias in the older and younger cohorts (Note that the NL sample has no members of the Netherlands professional society– the Nederlandse Astronomen Club (NAC)– that hold either tenured or postdoc positions abroad).

Table 9: Year of most recent and of most frequently cited paper as a function of year of Ph.D.

most recent cited paper					
year of paper	≤ 1960	61-70	71-80	81-90	total
≤ 1960					
1961-65					
1966-70		1			1
1971-75		2			2
1976-80	1	1	1		3
1981-85	1	3	7	1	12
1986-91	4	16	31	28	79
most frequently cited paper					
year of paper	≤ 1960	61-70	71-80	81-90	total
≤ 1960	2	1			3
1961-65	1	2			3
1966-70		4	1		5
1971-75		2			2
1976-80	1	3	14		18
1981-85	1	9	15	7	32
1986-91	1	4	9	22	36

The conclusion from the top part of table 11 is that the AAS and the Netherlands compare very well (certainly within the errors) and that the RAS has clearly lower citation rates. For the comparison with the AAS we should furthermore recall (see also discussion in van der Kruit, 1994) that it is an established fact that American astronomers usually publish in American journals and that papers in these journals are on average likely to get more citations. On the other hand, it is easy to identify US institutes that have very high citation rates.

The further panels of table 11 show that the visibility of Netherlands astronomy is in observational studies, especially concerning stars, interstellar medium and our own and other galaxies and using in particular UV, IR and optical facilities (but NL still scores higher for radio than the AAS and in particular the RAS). Observational astronomy in the Netherlands recieves more citations than theoretical astronomy; for the AAS the difference is smaller, but the RAS is more theoretical. A much larger percentage of astronomers in the Netherlands is classified as observers than in the AAS and the RAS, and there are much fewer theorists. The RAS does best in the latter category. The category instruments is probably inherently less frequently cited. There is in the Netherlands somewhat less emphasis on HEAP and cosmology, at least I classify relatively few astronomers as working primarily in those fields. Again I should warn against comparisons of citation rates between subfields.

Trimble has listed the ten highest cited astronomers in the AAS and the RAS. Because of the better statistics it provides, I take the average of the annual citations 1990-92 here for the Netherlands equivalent. We then get H.C. van de Hulst (234), P.C. van der Kruit (137), E. Hummel (128), E. F. van Dishoeck (120), S.R. Pottasch (117), J.H. Oort (108), E.P.J. van den Heuvel (91), P.D. Barthel (90), J.M. Greenberg (87) and C. de Jager (86). Here citations to books have been included. The AAS and RAS samples had mostly theoreticians; the Netherlands has a

Table 10: Distribution of most frequently cited paper over facilities used as a function of the year of publication.

Facility	≤ 75	76-80	81-85	86-90	total
Theory/Interpr.	8	5	12	10	35
COS-B	-	-	-	2	2
TD-1	1	-	-	-	1
EXOSAT	-	-	3	2	5
ANS	-	-	1	-	1
IUE	-	-	2	-	2
Hartebeespoortdam	-	4	-	-	4
Jungfraujoch	-	-	1	-	1
ESO	-	2	2	6	10
La Palma	-	-	-	-	-
Other optical	3	-	1	3	5
IRAS	-	-	3	-	3
UKIRT	-	-	1	1	2
JCMT	-	-	-	-	-
Dwingeloo	-	-	2	1	3
WSRT	-	4	5	2	11
VLA	-	-	1	3	4
Other radio	-	1	-	-	1

larger fraction of observers. The most-cited AAS astronomer (William Press) has 908 citations, for the RAS it is 556 (Stephen Hawking).

It is not so much of interest to establish these names as to ask the following questions: (1) Does the list change rapidly with time? (2) Do astronomers with high citation rates owe this to a single paper? For the first question we may look at the same table, but now for the years 1986-89. This gives H.C. van der Hulst (205), J.H. Oort (141), P.C. van der Kruit (131), S.R. Pottasch (127), E. Hummel (108), E.P.J. van den Heuvel (107), E.F. van Dishoeck (102), M. van der Klis (94), H.J.G.L.M. Lamers (92) and C. de Jager (86). This list has 8 names in common with the one above, suggesting that the change is slow. Visibility, once acquired, remains for a timescale of years.

On a year to year basis there are (as expected) larger fluctuations. If we draw up the yearly lists for the years 1986 to 1992, then we see that H.C. van der Hulst, P.C. van der Kruit, J.H. Oort and S.R. Pottasch appear on all 7. E.P.J. van den Heuvel is on 6 and E.F. van Dishoeck, E. Hummel and C. de Jager are on 5. These are also the 8 names common to the two multiple-year averaged lists above. Other names on the lists are H.J.G.L.M. Lamers (4 times), P.D. Barthel and J. van Paradijs (3 times), T.S. van Albada, J.M. Greenberg, M. van der Klis and F. Verbunt (twice), K.A. van der Hucht, F.P. Israel and R.H. Sanders (once).

For the second question we may look in the first place at the number of cited publications, as determined for 1991. In the following the first number between brackets is the number of cited publications and the second the number of citations to the most frequently cited paper (not a book or review paper). The highest number of cited publications were for J.M. Greenberg (51, 7), C. de Jager (46, 14), P.C. van der Kruit (43, 15), J.H. Oort (42, 4), E.P.J. van den Heuvel

Table 11: Comparison of mean citation rates and sample sizes to Trimble's studies.

(Sub-)group	AAS		RAS		NL	
	cits/yr	#	cits/yr	#	cits/yr	#
All	28	393	22	188	36	103
Universities	40	162	28	78	39	74
U+O/I/L	33	303	26	148	36	103
U+O/I/L (1968-81)	37	162	20	58	40	44
U+O/I/L (1957-81)	37	200	26	83	39	63
		%		%		%
Theory	28	34	30	35	26	17
Observations	31	55	20	49	41	71
Instruments	19	12	14	17	9	12
Sun	27	9	12	6	17	8
Solar system	24	12	17	5	22	8
Dynamics	26	4	17	10	-	-
Stars	22	27	24	25	38	31
MW+ISM	29	13	26	14	35	21
Galaxies	51	13	36	13	50	19
HEAP	36	17	27	18	31	8
Cosmology	73	5	40	10	26	3
X+γ	30	9	27	21	25	15
UV+IR	24	8	11	13	49	15
Optical	29	47	25	41	43	31
Radio	31	26	13	26	36	39

(41, 11), E. Hummel (40, 13), F.P. Israel (38, 9), E.F. van Dishoeck (36, 26), J. van Paradijs (34, 13) and S.R. Pottasch (34, 8). So, this group had on average 41 publications cited, but the most frequently cited paper had on average only 12 citations. Since these are mostly the persons with the highest total citations, it means that a high citation rate is a result of a large set of cited publications and not a high citation rate for an individual paper.

Indeed, if we draw up a list of persons with the highest number of citations to their most frequently cited paper, we end up with a different set of names (except Ewine van Dishoeck). Now the numbers between brackets are the opposite from above, namely first the citations to the most frequently cited paper and then the number of cited publications. The highest scores now are P.D. Barthel (43, 11), F.R. Klinkhamer (33, 4), E.F. van Dishoeck (26, 36), J.B.G.M. Bloemen (21, 13), J. Koornneef (21, 11), K. Horne (20, 18), K.A. van der Hucht (20, 12), R. Mewe (20, 28), K. Kuijken (19, 8) and P. de Korte (18, 1). Their average highest citation rate is 24 and their average number of cited publications 14. The mean year of publication of the highly cited, most frequenly cited papers is 1985.4 ± 2.7, so these are papers that in most cases should be over the peak in their citation rates. It follows from this that a high total citation rate is accomplished by the production of a large set of papers that keep getting reasonable citation rates rather than the production of a single, highly cited paper. Visibility depends primarily on a person's total record.

Table 12: Comparison of citation statistics to Jaschek's study.

	Spain	France	Sweden	Germany	Switzerland	Netherlands
All IAU members						
N	120	506	73	323	50	140
$\langle C \rangle$	4.2	10.6	13.2	15.4	23.7	22.6
$\langle C' \rangle$	3.9	10.1	10.3	15.1	20.6	21.3
M	0.6	4.2	6.0	6.4	10.7	10.0
IAU members with at least 2 citations						
N	54	352	45	234	38	87
$\langle C \rangle$	9.1	15.1	21.2	21.2	31.2	36.2
$\langle C' \rangle$	8.5	14.5	16.5	20.7	27.2	34.1
M	5.5	9.4	13.0	12.5	15.0	21.5

Finally, I compare the data to the study of Jaschek (1992). He uses the 1988 membership list of the IAU as basis. He argues that these are astronomers in a real sense, since they are proposed as members by their national committees on the basis of well-defined criteria (scientific achievement, activity in research) and the samples should be uniform and comparable. I checked this using the Netherlands membership list for 1988. It totals 140 IAU members. Three IAU members were at ESA (ESTEC Noordwijk; these are usually not regarded as part of the Netherlands astronomical community). Of the remaining 137, I found that in 1990 (the year for which Jaschek uses citation data) only 79 can be classified as at that time active in astronomical research; 48 were known to me to be no longer active astronomers –and had not been that for at least 5, but sometimes more than 10 years. The remaining 10 are active in supporting research as technical staff (senior engineers for instrumentation programs) or in software development. The 48 were mostly either genuinely retired (no longer involved with research) or had moved to other fields (physics or mathematics, administration) outside astronomy and none of these were holding astronomical research positions at universities or other institutes. There were even 13 names that I had never heard of, in spite of the fact that our community is relatively small. I do not know about the other countries, but certainly for the Netherlands the IAU membership list is not a good reflection of the active research community *at the present time*. This is not to say that the 48 persons no longer active in astronomical research did not conform to the criteria at the time they were proposed as IAU members. Needless to say, that a check of the citation index showed that these 48 astronomers with a few exceptions had 0 or sometimes 1 citation in 1990, but none of the 13 "unknown" persons had 2 or more citations.

Jaschek's study concerns 5 West-European countries, namely France, Germany (the former FRG), Spain, Sweden and Switzerland. He used 1990 citations and calculates the mean citation rate $\langle C \rangle$, the same but now with the highest score deleted $\langle C' \rangle$ (in some countries these turned out to be not 'pure' astronomers), and the median M. Using the IAU list and the present data I can perform the same analysis as Jaschek and the result is in the top panel of table 12 (N is the sample size).

In view of the above discussion, it would seem better to delete those persons with 0 or 1 citation. For the Netherlands this certainly is justified and probably for all countries this most likely also reflects better the currently active astronomical community. The results of that are in the bottom part of table 12. The conclusion is that the highest visibility obtaines for the

Netherlands with the small community of Switzerland only slightly below. Trimble (1993b) quotes the mean citation rates for IAU members as 32.5 for the USA and 23.6 for the UK. Note, however, that these numbers are not completely comparable, since she kept all persons with 1 citation in and of those that had no citations in 1990 half their 1989 citations and these USA and UK numbers must therefore be underestimated with respect to the others.

For comparison I repeat the ranking based on the (1981-85) astronomy output and citations in van der Kruit (1994) of the sample of countries studied in this section. The order obtained there was Netherlands, USA, Germany, Switzerland, UK, France, Sweden, Spain. The result is in general in good agreement in spite of the different years, samples and methods used.

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