

Statistics of Scientific Citations

Empirical facts about scientific citations

Systematics:

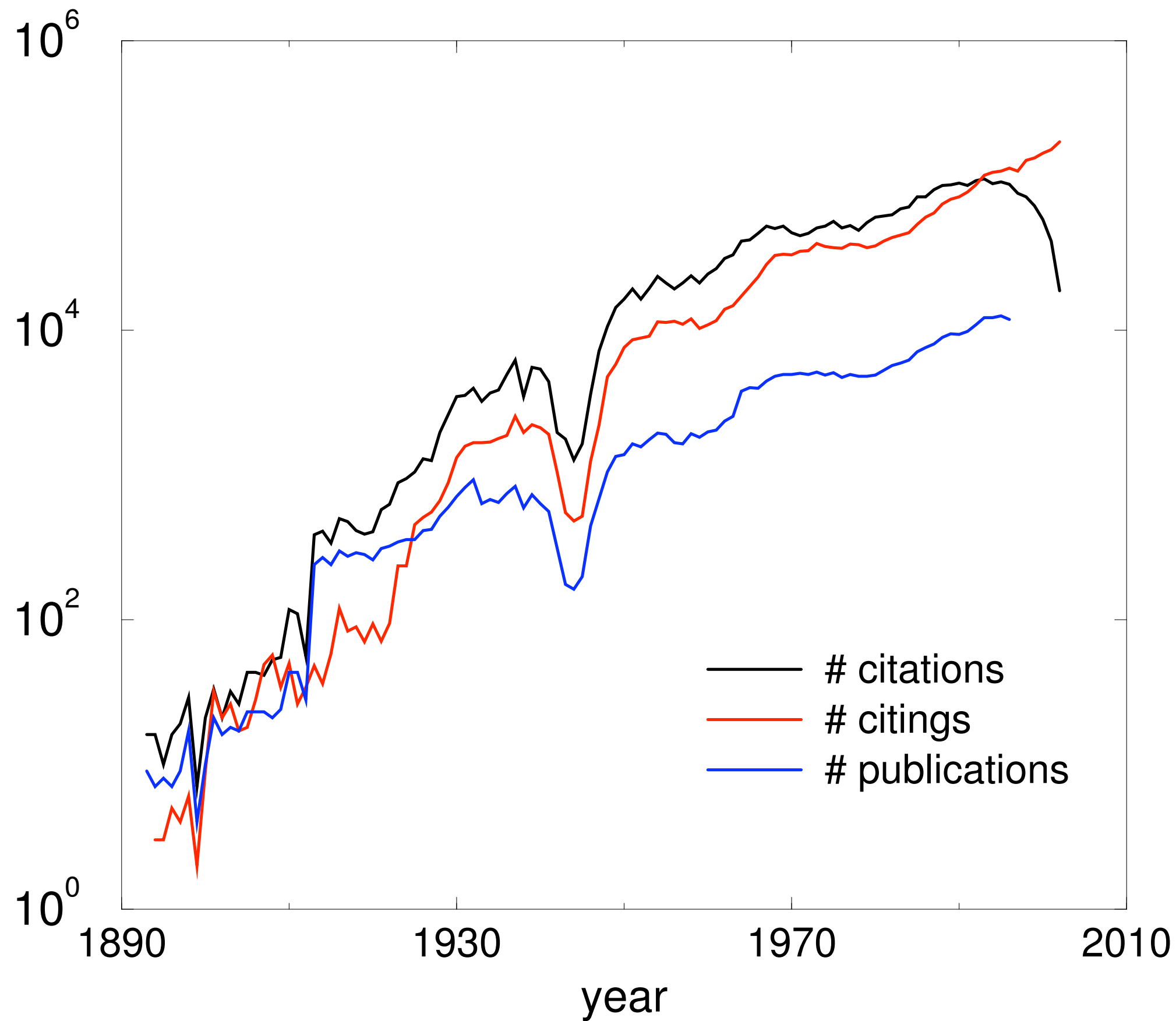
*journal growth, citation distribution,
preferential attachment, age-citation correlation,
citation memory, number of references*

Idiosyncratics:

*top-10 lists,
citation histories,
outstanding individuals*

Google page rank analysis

Growth of PR Journals, 1893-2003



Citation Numbers

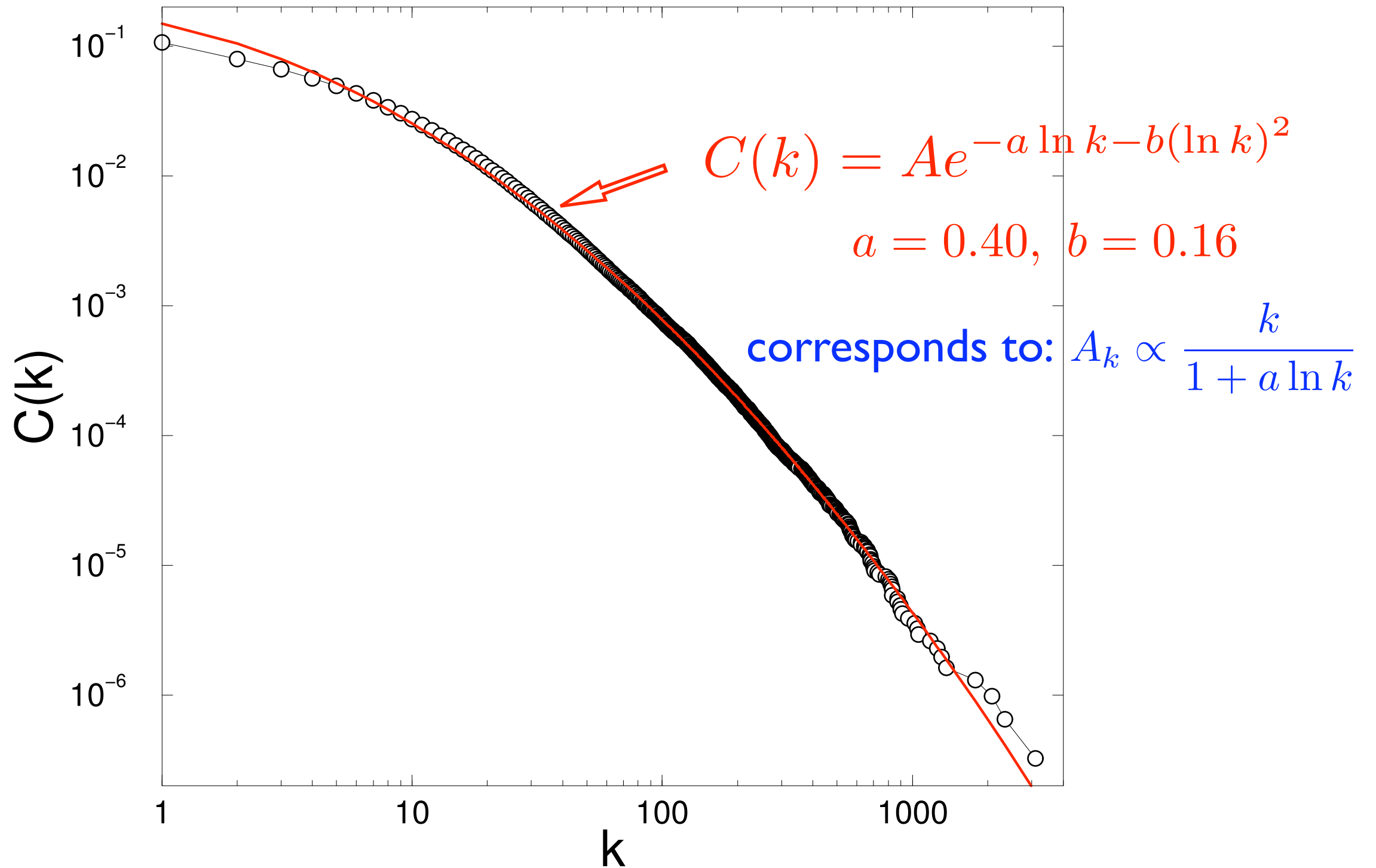
353,268 papers, 3,110,839 cites

$\langle \# \text{ cites} \rangle = 8.81$, $\langle \text{cite age} \rangle = 6.20$

N.B.: *Internal* citations only; undercount by factor of 3-5.
(for highly cited HEP papers; SPIRES)

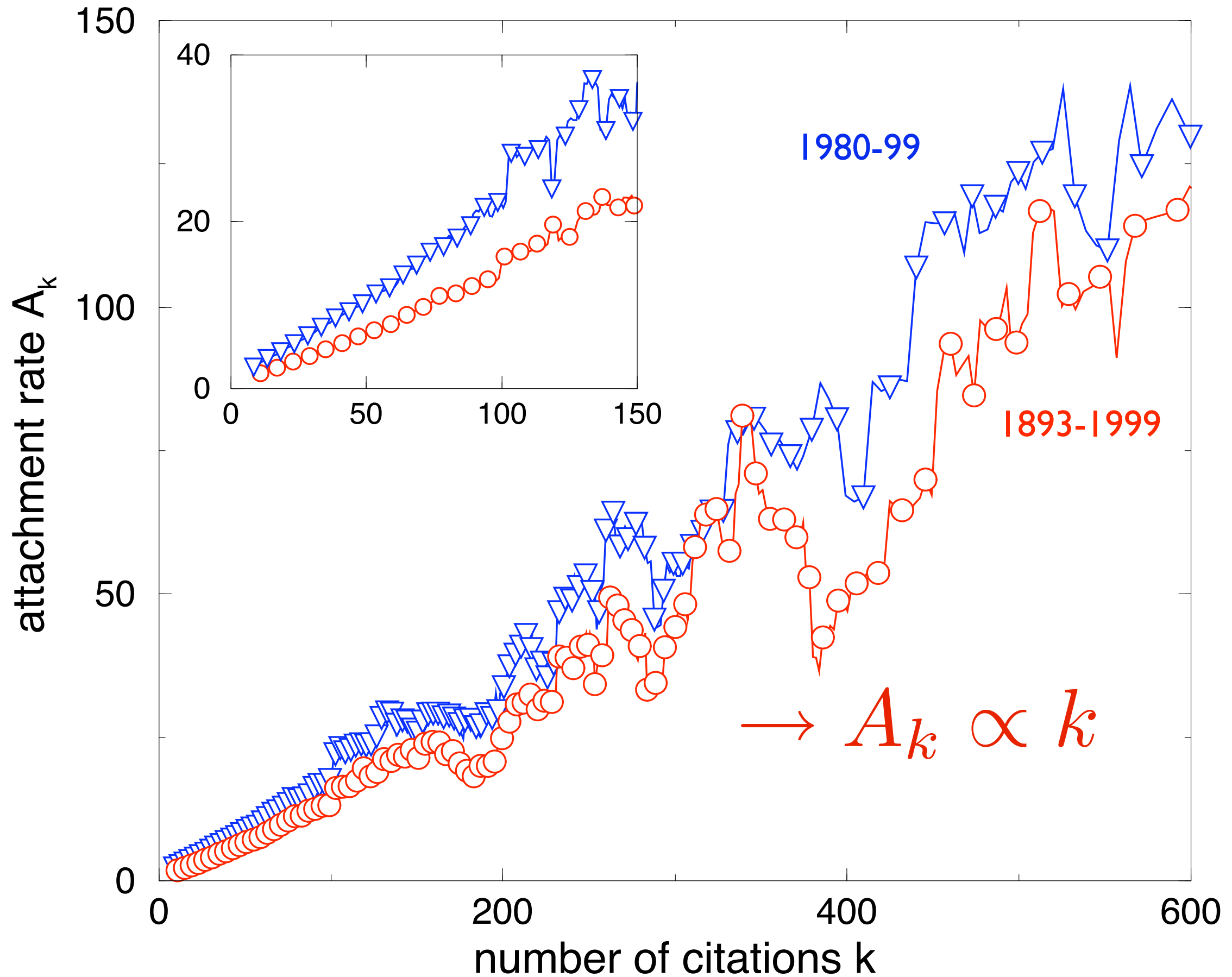
11	papers with >	1000	citations
79	papers with >	500	citations
237	papers with >	300	citations
2340	papers with >	100	citations
8073	papers with >	50	citations
245459	papers with <	10	citations
84144	papers with	1	citation
23421	papers with	0	citations

Citation Distribution



Attachment rate for PR publications

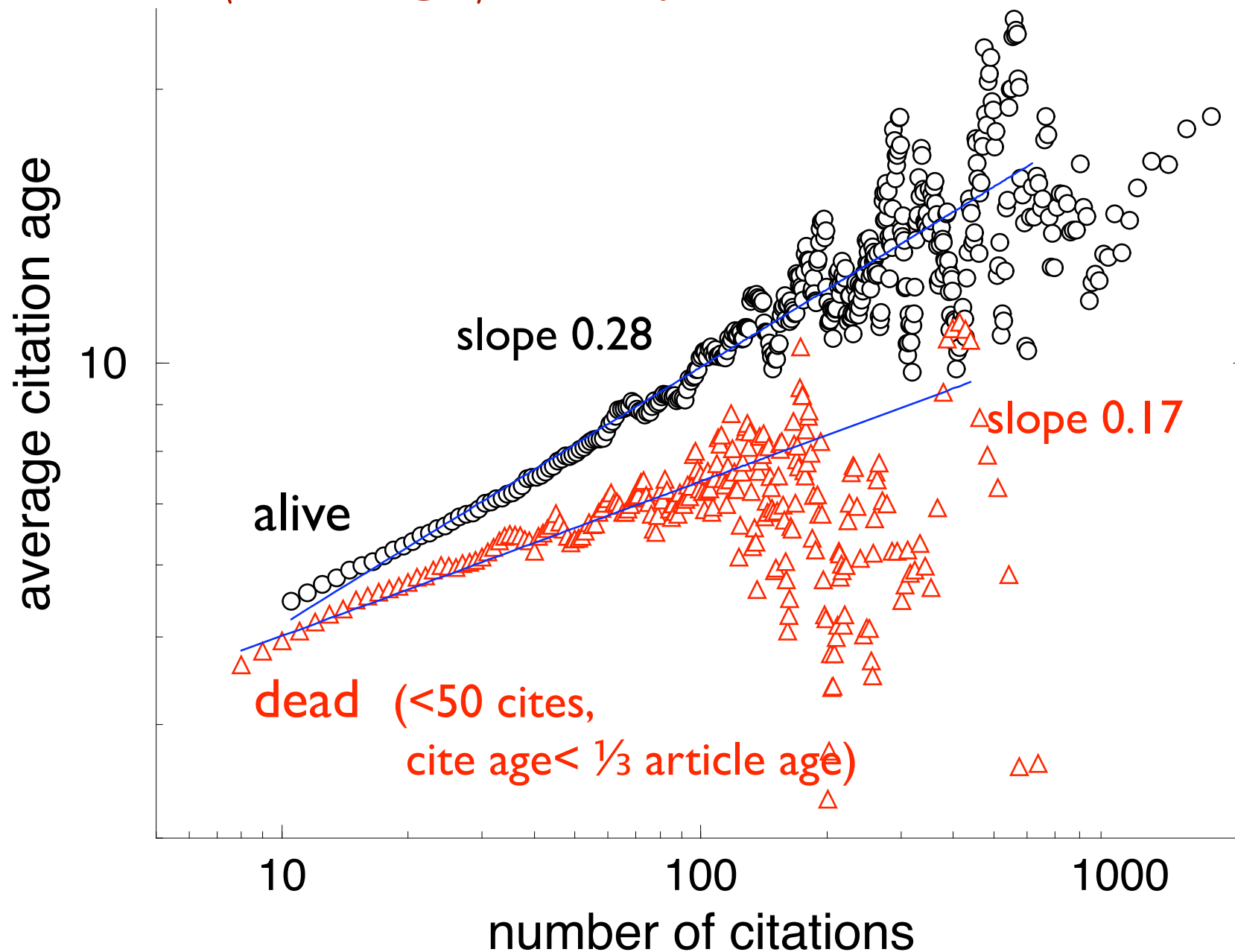
Jeong et al (2003)
SR (2004)



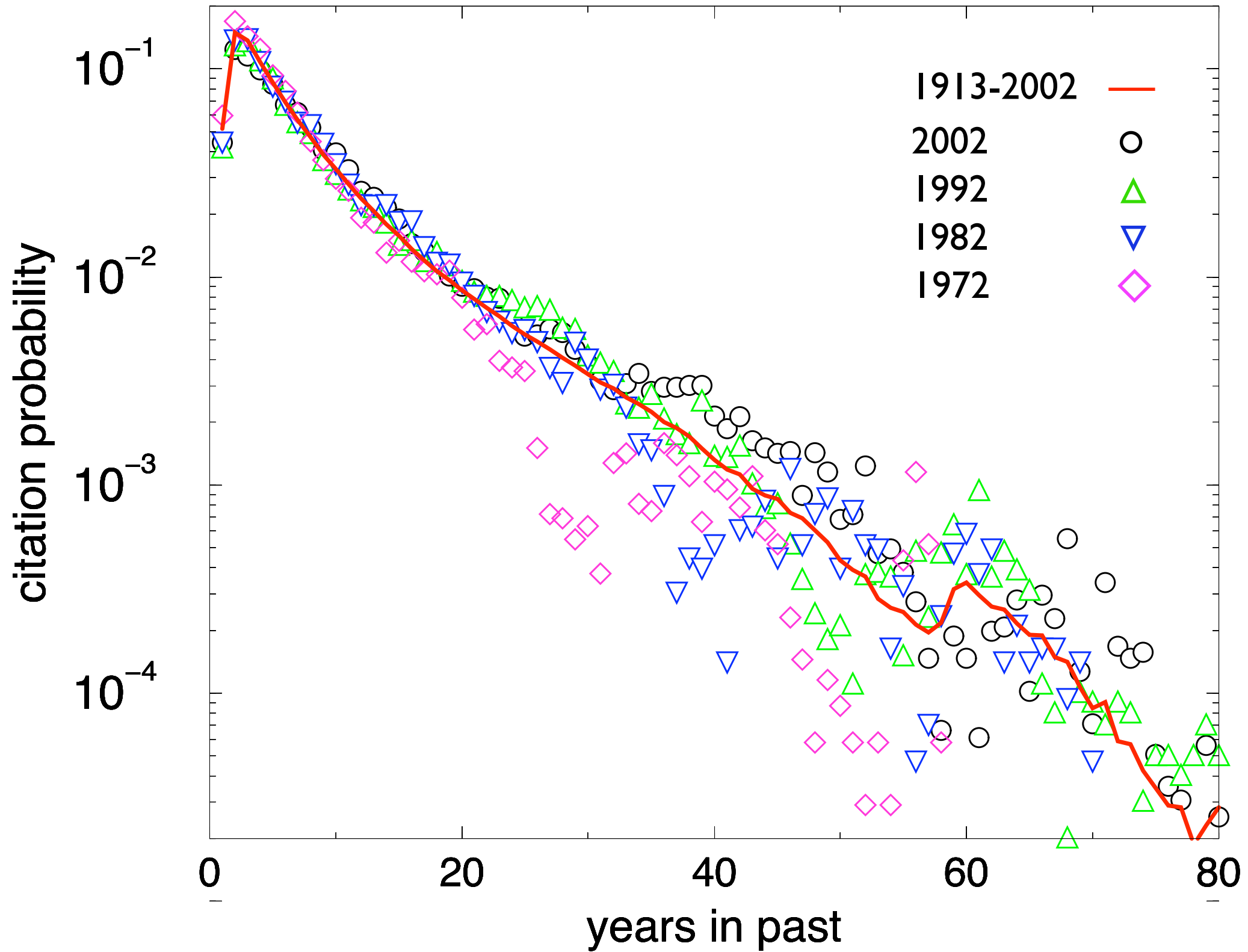
Age Citation Correlation

$$\langle \# \text{ cites} \rangle = 8.81, \quad \langle \text{cite age} \rangle = 6.20$$

- > 100 citations, $\langle \text{cite age} \rangle = 11.7$ years
- > 300 citations, $\langle \text{cite age} \rangle = 14.6$ years
- > 1000 citations, $\langle \text{cite age} \rangle = 18.9$ years
- $\langle \text{cite age} \rangle < 2$ years, 3.6 citations

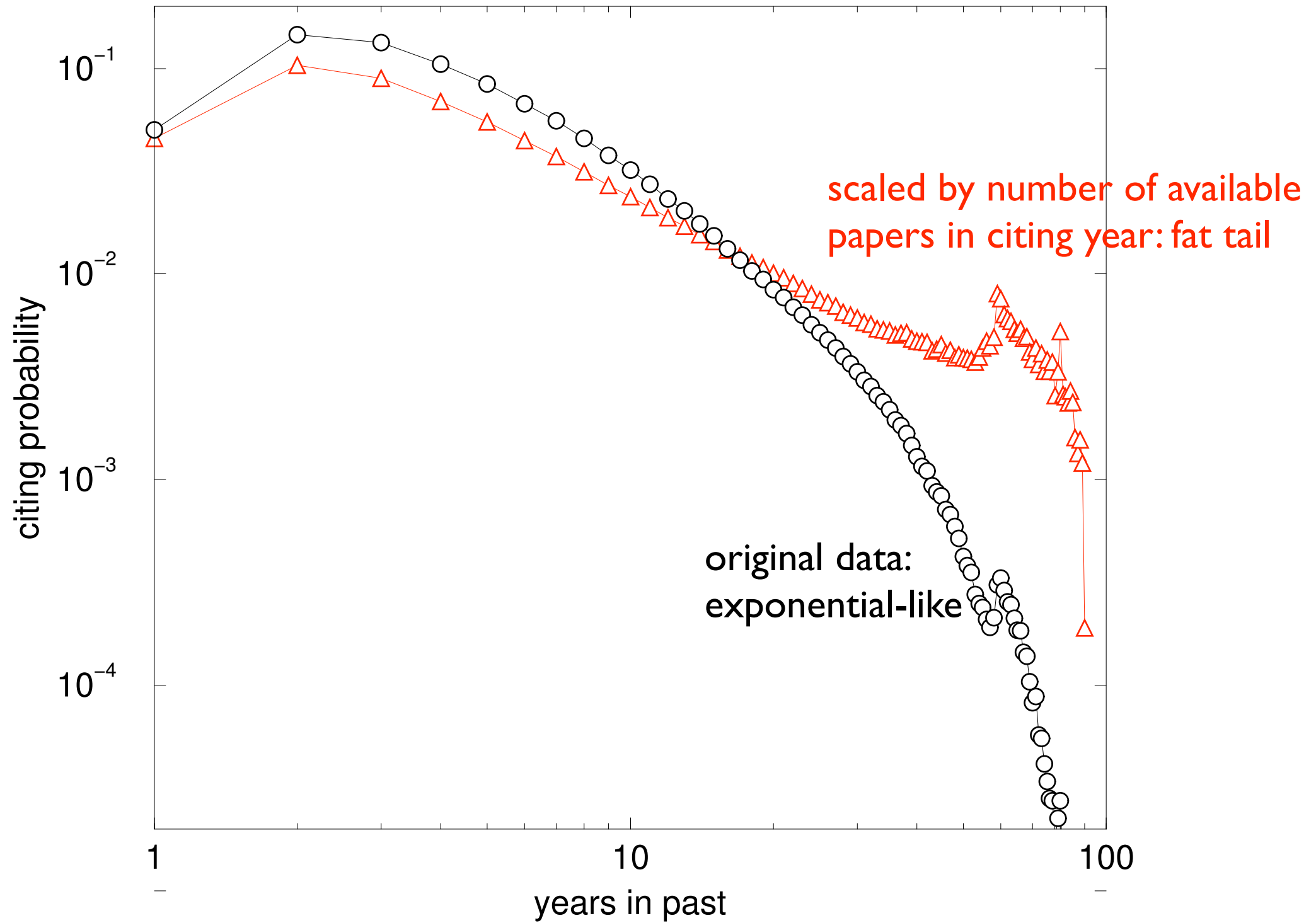


Citing History

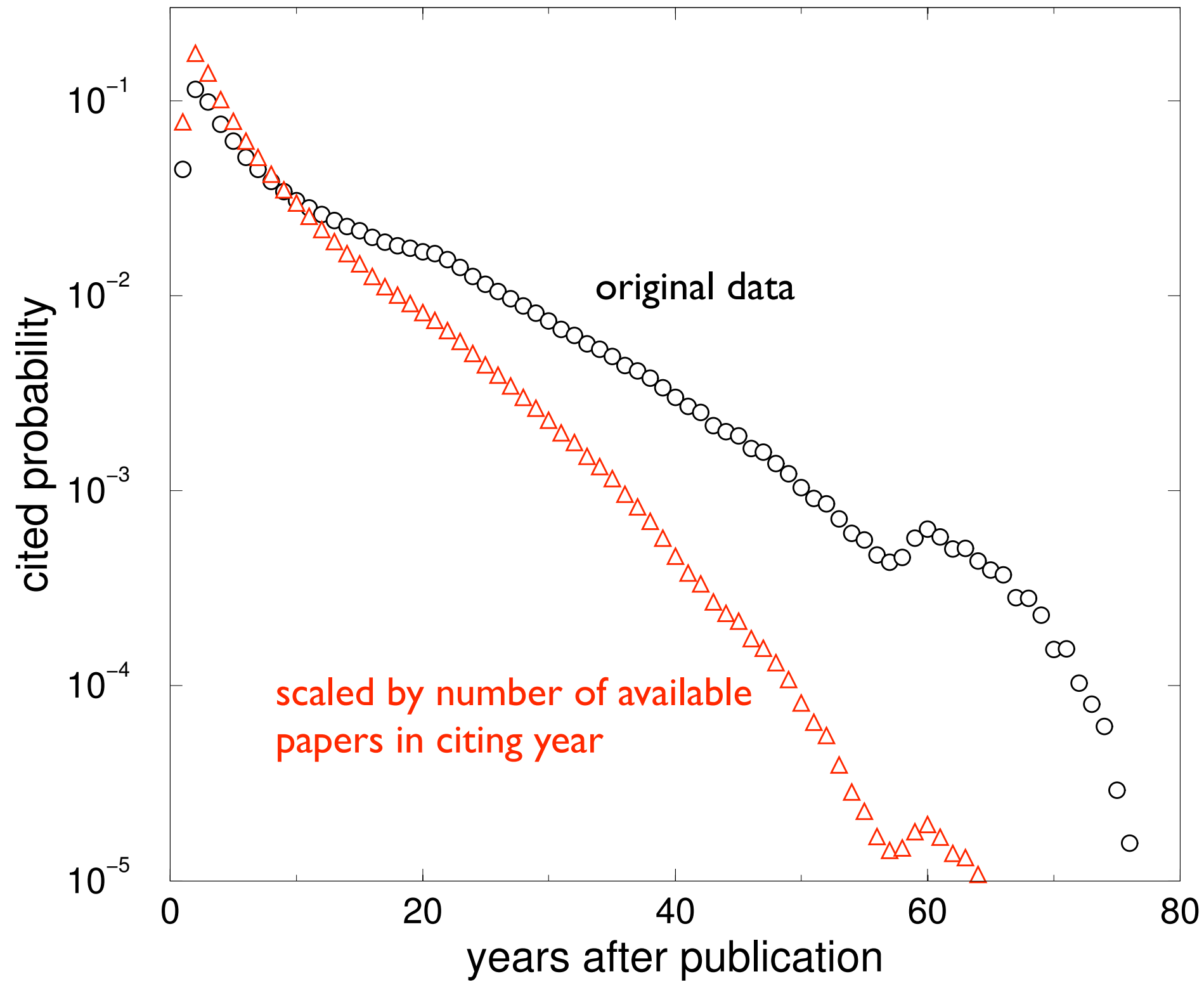


Scaled Citing History

Nakamoto (1988)

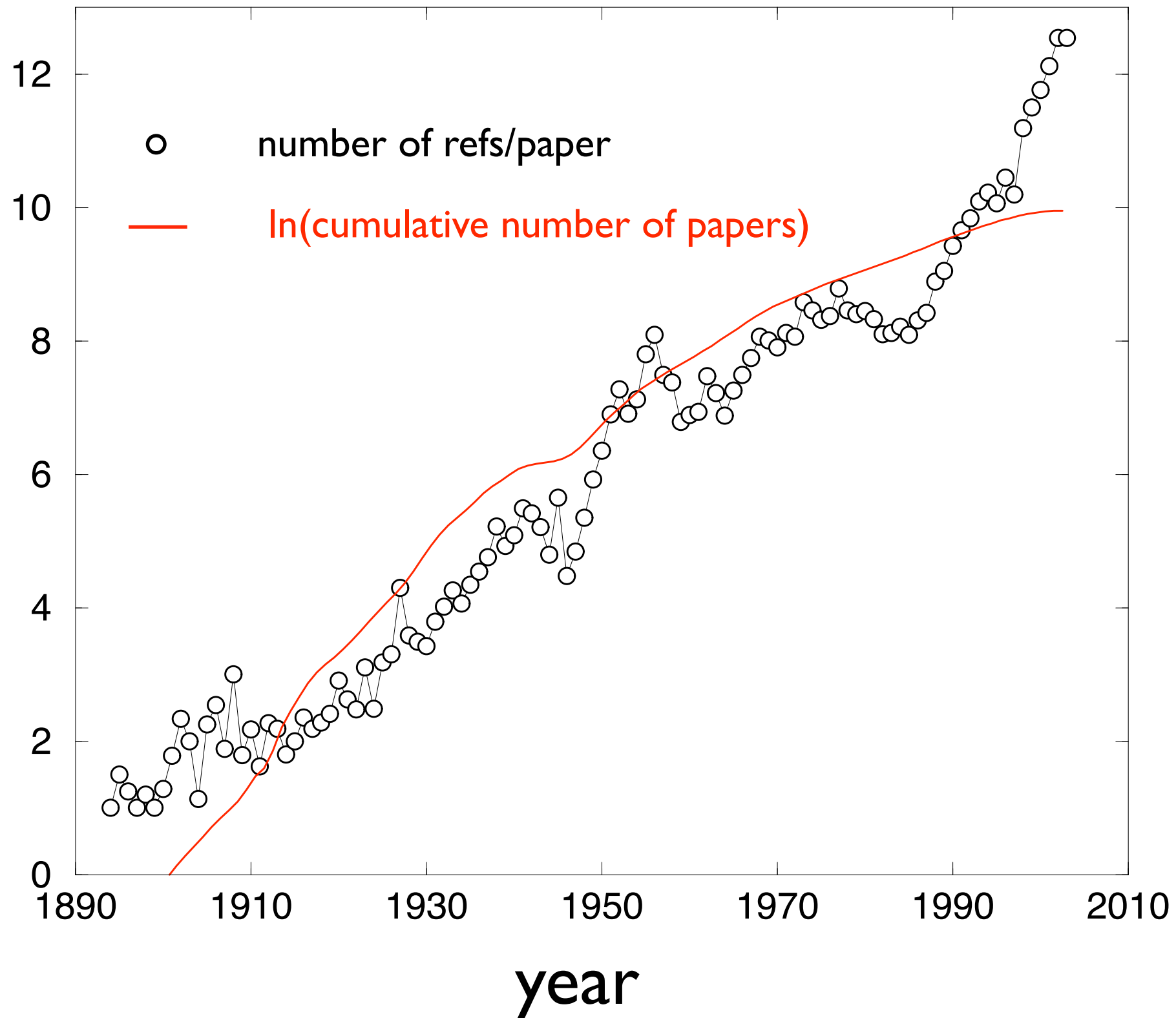


Scaled Cited History



Number of References vs. Time

→ *logarithmic densification*



Citation Features of Individual Publications

top-10 lists

citation histories

outstanding individuals

PR papers with > 1000 cites

		article	cites	\langle age \rangle	impact	title	author(s)
1	PR	140 A1133 (1965)	3786	26.7	85972	Self Consistent Equations..	W. Kohn & L. J. Sham
2	PR	136 B864 (1965)	2460	28.7	70604	Inhomogeneous Electron Gas..	P. Hohenberg & W. Kohn
3	PRB	23 5048 (1981)	2079	14.4	29896	Self-Interaction Correction to..	J. P. Perdew & A. Zunger
4	PRL	45 566 (1980)	1781	15.4	27463	Ground State of the Electron..	D. M. Ceperley & B. J. Alder
5	PR	108 1175 (1957)	1364	20.2	27526	Theory of Superconductivity	Bardeen, Cooper, Schrieffer
6	PRL	19 1264 (1967)	1306	15.5	20191	A Model of Leptons	S. Weinberg
7	PRB	12 3060 (1975)	1259	18.4	23103	Linear Methods in Band Theory	O. K. Andersen
8	PR	124 1866 (1961)	1178	28.0	32949	Effects of Configuration..	U. Fano
9	RMP	57 287 (1985)	1055	9.2	9674	Disordered Electronic Systems	P. A. Lee & T. V. Ramakrishnan
10	RMP	54 437 (1982)	1045	10.8	11307	Electronic Properties of..	T. Ando, A. B. Fowler, & F. Stern
11	PRB	13 5188 (1976)	1023	20.8	21227	Special Points for Brillouin..	H. J. Monkhorst & J. D. Pack

Top 10 PR papers ranked by citation impact

		article	cites	\langle age \rangle	impact	title	author(s)
1	PR	140 A1133 (1965)	3227	26.7	85972	Self Consistent Equations..	W. Kohn & L. J. Sham
2	PR	136 B864 (1965)	2460	28.7	70604	Inhomogeneous Electron Gas..	P. Hohenberg & W. Kohn
3	PR	124 1866 (1961)	1178	28.0	32949	Effects of Configuration..	U. Fano
4	PR	40 749 (1932)	561	55.8	31281	On the Quantum Correction..	E. Wigner
5	PRB	23 5048 (1981)	2079	14.4	29896	Self-Interaction Correction to..	J. P. Perdew & A. Zunger
6	PR	82 403 (1951)	643	46.4	29803	Interaction Between d-Shells..	C. Zener
7	PR	47 777 (1935)	492	59.6	29343	Can Quantum Mechanical..	E. Einstein, B. Podolsky, N. Rosen
8	PR	46 1002 (1934)	557	51.5	28680	On the Interaction..	E. Wigner
9	PR	109 1492 (1958)	871	32.0	27872	Absence of Diffusion in..	P. W. Anderson
10	PR	108 1175 (1957)	1364	20.2	27526	Theory of Superconductivity	Bardeen, Cooper, Schrieffer

Outstanding Individual Statistics

Individuals with ≥ 2 papers in top-100 citation impact:

W. Kohn: 1, 2, 24, 96, 100

P. W. Anderson: 9, 19, 20, 35, 41

E. P. Wigner: 4, 8, 53, 55

L. Onsager: 16, 64, 68

J. C. Slater: 12, 27, 40

Two Each: J. Bardeen, C. P. Bean, R. H. Dicke, R. J. Glauber, D. R. Hamann, P. Hohenberg, J. M. Luttinger, Y. Nambu, E. M. Purcell, M. Schluter, J. Schwinger, G. H. Wannier, and J. A. Wheeler

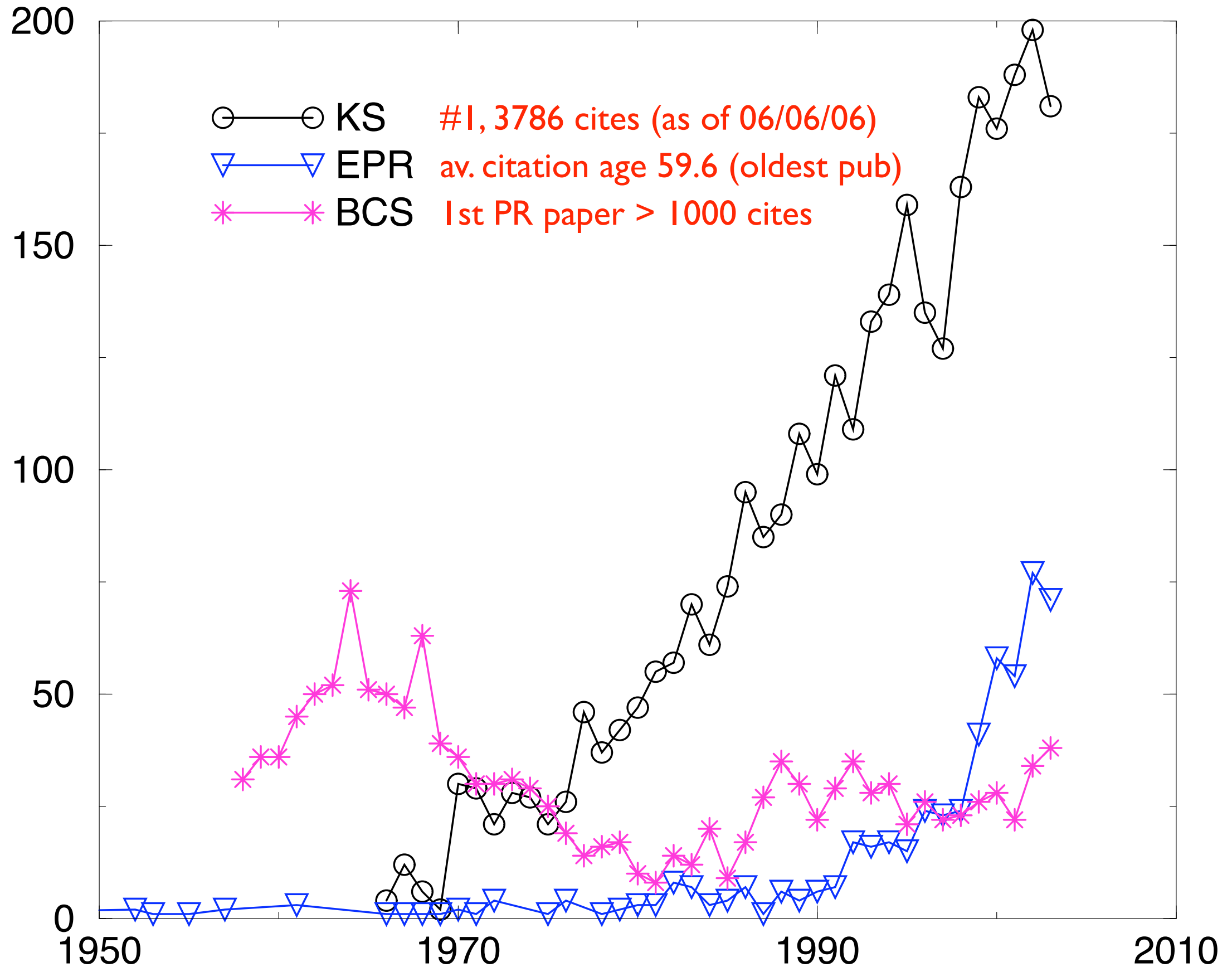
Only 3 experimental papers in top-100 citations (also top-100 citation impact):

56. N. Bloembergen et al., Phys. Rev. 73, 679 (1948)

66. E. Wollan, W. Koehler, Phys. Rev. 100, 545 (1955)

81. E. Hahn, Phys. Rev. 80, 580 (1950)

Citation histories of 3 classic PR papers



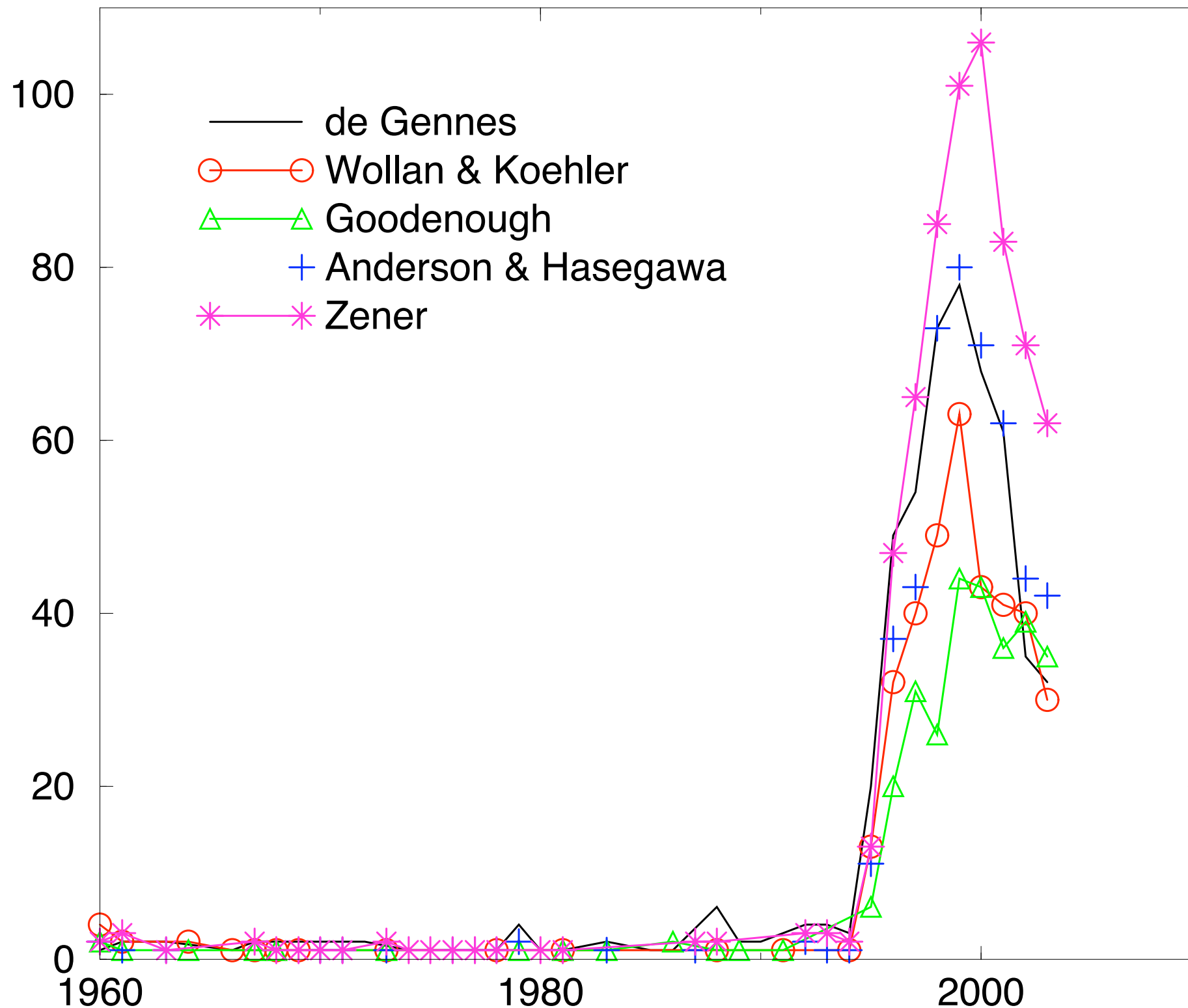
“Sleeping Beauties”

cites > 300

$\langle \text{cite age} \rangle / \text{paper age} > 3/4$

8 papers total, 5 on double exchange

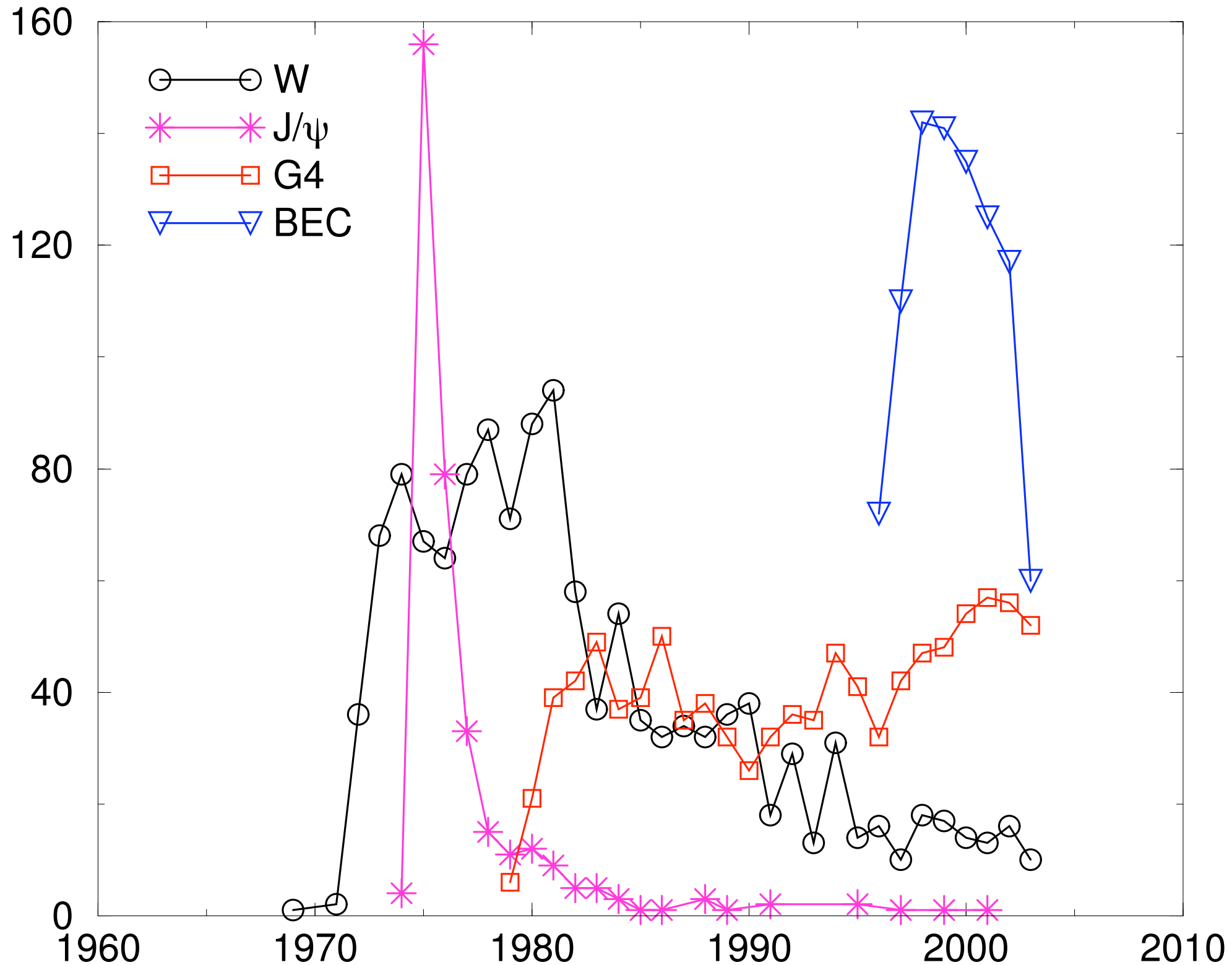
\Rightarrow colossal magnetoresistance



Discovery Publications

cites > 300
<cite age>/paper age < 0.4

39 papers, 22/25 HEP <1975, all 14 CMP >1975



Google Page Rank for Citations Brin & Page (1999)

Basic equation:

$$G_i = (1 - d) \sum_{j \text{ nn } i} \frac{G_j}{k_j^{\text{out}}} + \frac{d}{N}$$

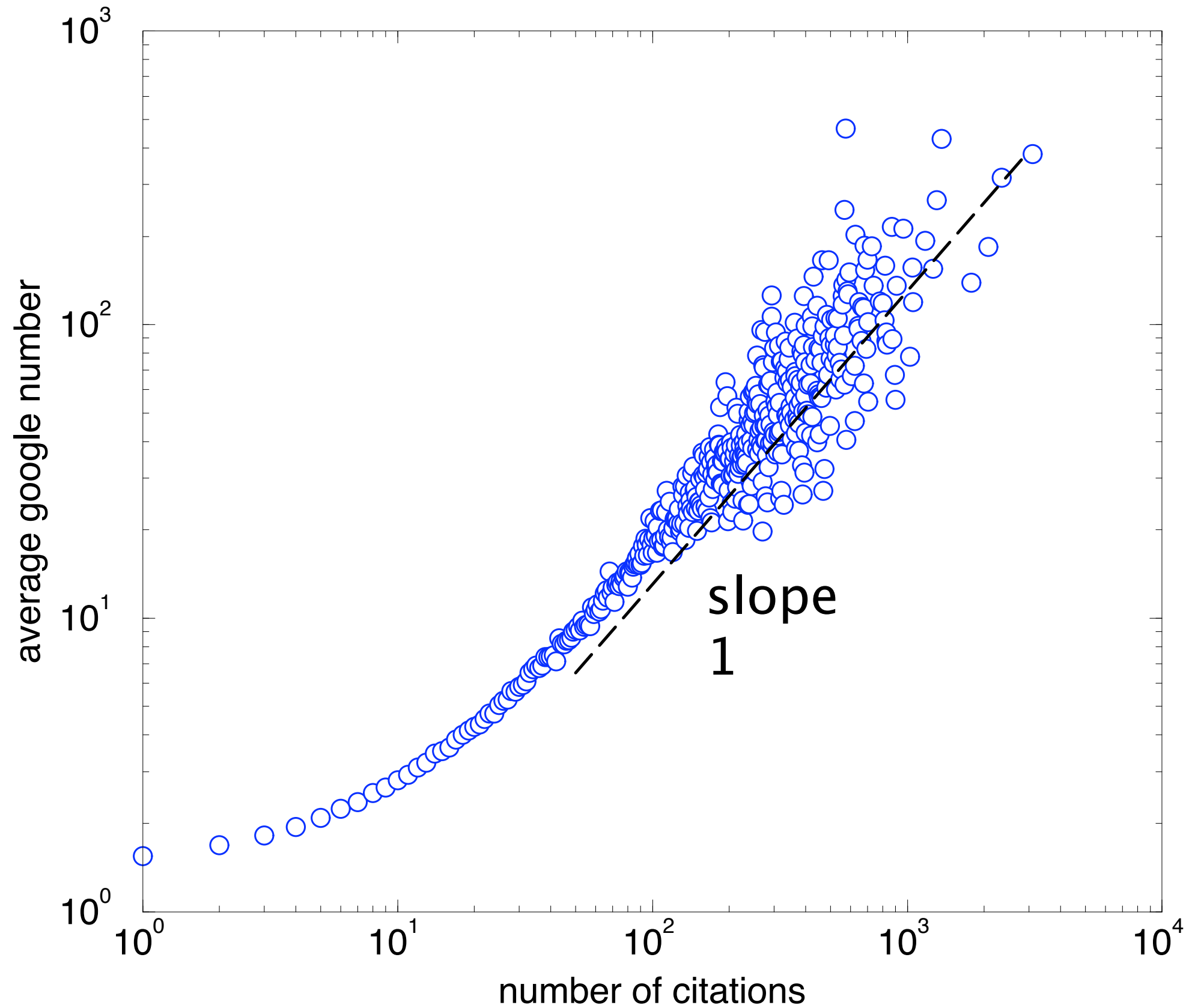
random walk propagation

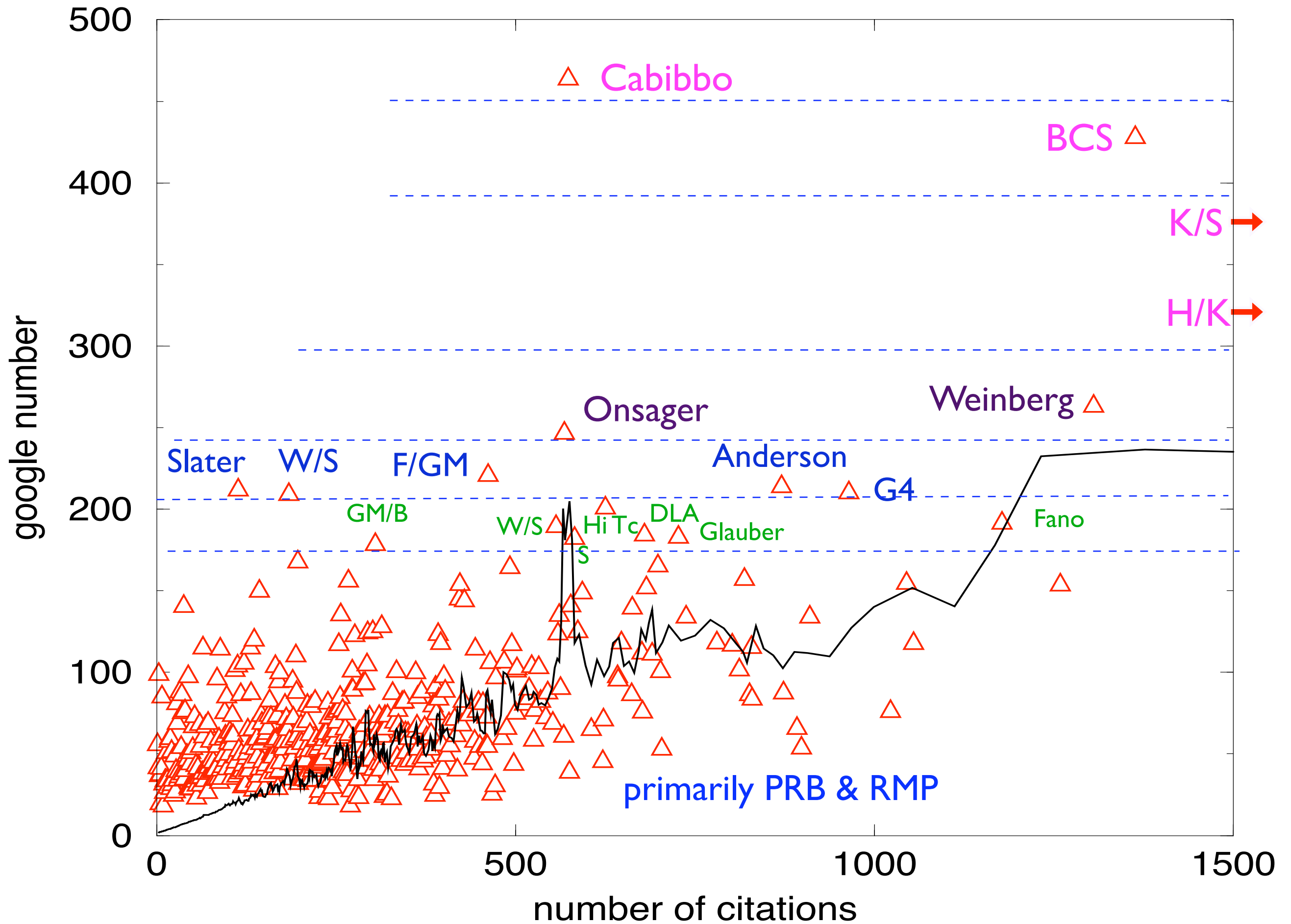
“manna from heaven”

For $d = 0$ & undirected network: $G_i \propto k_i = \text{degree}_i$

For $d > 0$ & directed network: $G_i = f(\text{global topology})$

Correlation between Google & citation counts





Future

Deeper analysis of citation data:
contextual information, specialization

Larger data sources:
test universality of citation statistics

Community structure:
visualization