

A case study of a scientific collaboration:  
Chornobyl-related research as a collective  
enterprise

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## Our lab

Research fields: ● Static and dynamic critical behavior of disordered magnets; ● conformational properties of complex polymer macromolecules; ● **complex networks**; ● **scaling in complex systems**; ● **scientometrics**

Current research projects:

- 2014-2017: FP7-PEOPLE, IRSES project N612707 "Dynamics of and in Complex Systems"(DIONICOS)
- 2011-2016: FP7-PEOPLE, IRSES project N295302 "Statistical Physics in Diverse Realizations"(SPIDER)
- 2011-2015: FP7-PEOPLE, IRSES project N269139 "Dynamics and Cooperative Phenomena in Complex Physical and Biological Media"(DCP-PHYSBIO)
- International Doctoral College "Statistical Physics of Complex Systems"(Nancy-Leipzig-Coventry-Lviv)
- 2013-2017: COST Action TD1210 "Analyzing the dynamics of information and knowledge landscapes - KNOWeSCAPE"

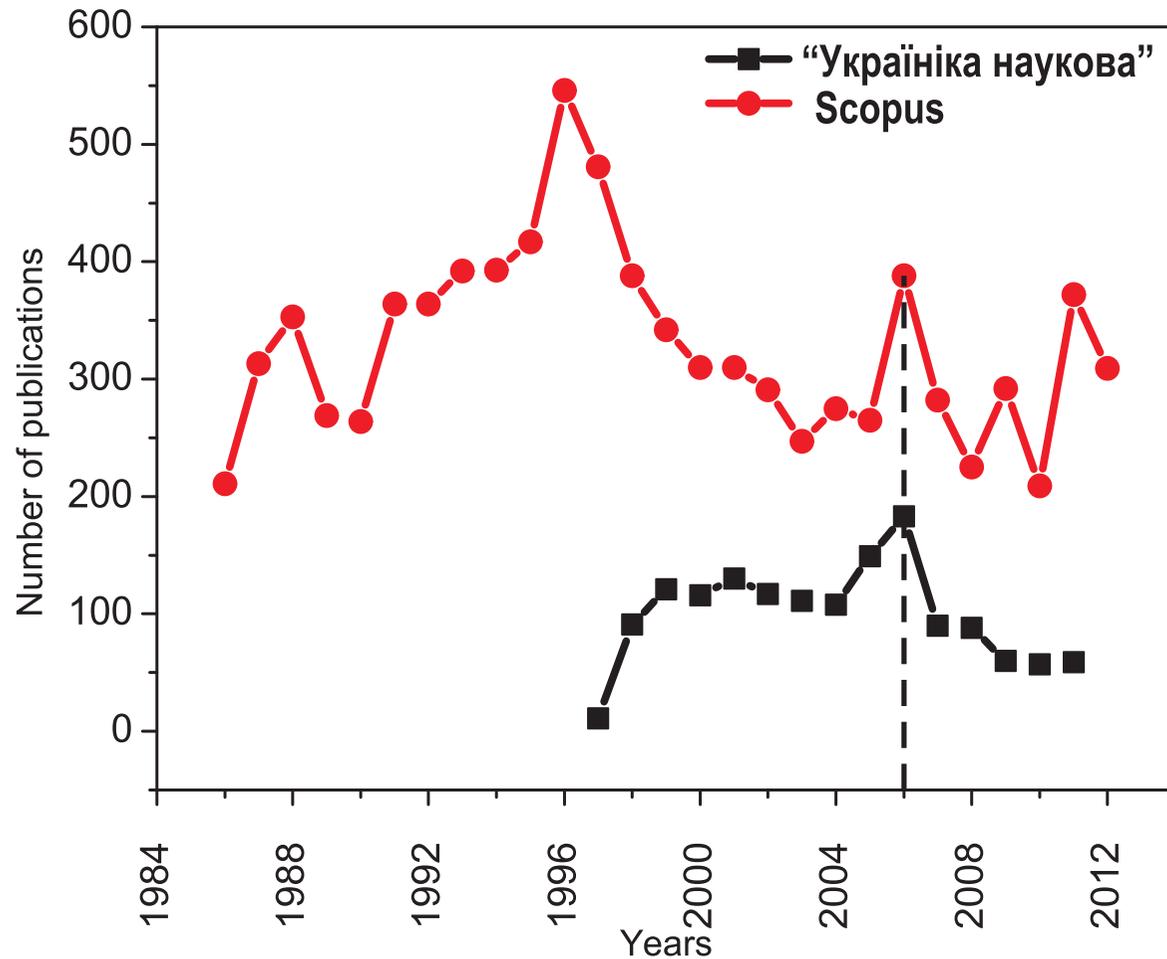
## Time and Place



# Motivation

- To analyze how does an academic community react on a particular urgent task which abruptly arises and poses also scientific problems
- To examine several scientometric features of Chornobyl-related research: its multidisciplinary landscape, grows rate, and collaboration strategy
- To compare contribution of the international community to the Chornobyl-related research as well as integration of Ukraine in the international research on this subject
- To detect the most important terms and visualize the structure of a scientific field
- cf. A. Zuccala, N.J. van Eck, Development Policy Review **29** (2011) 311

## Databases



**SEARCH:** *Chornobyl OR Chornobyl' OR Chernobyl OR Chernobyl'*

*Чорнобиль OR Черно-  
биль OR ЧАЕС OR ЧАЭС...*

1986–2012

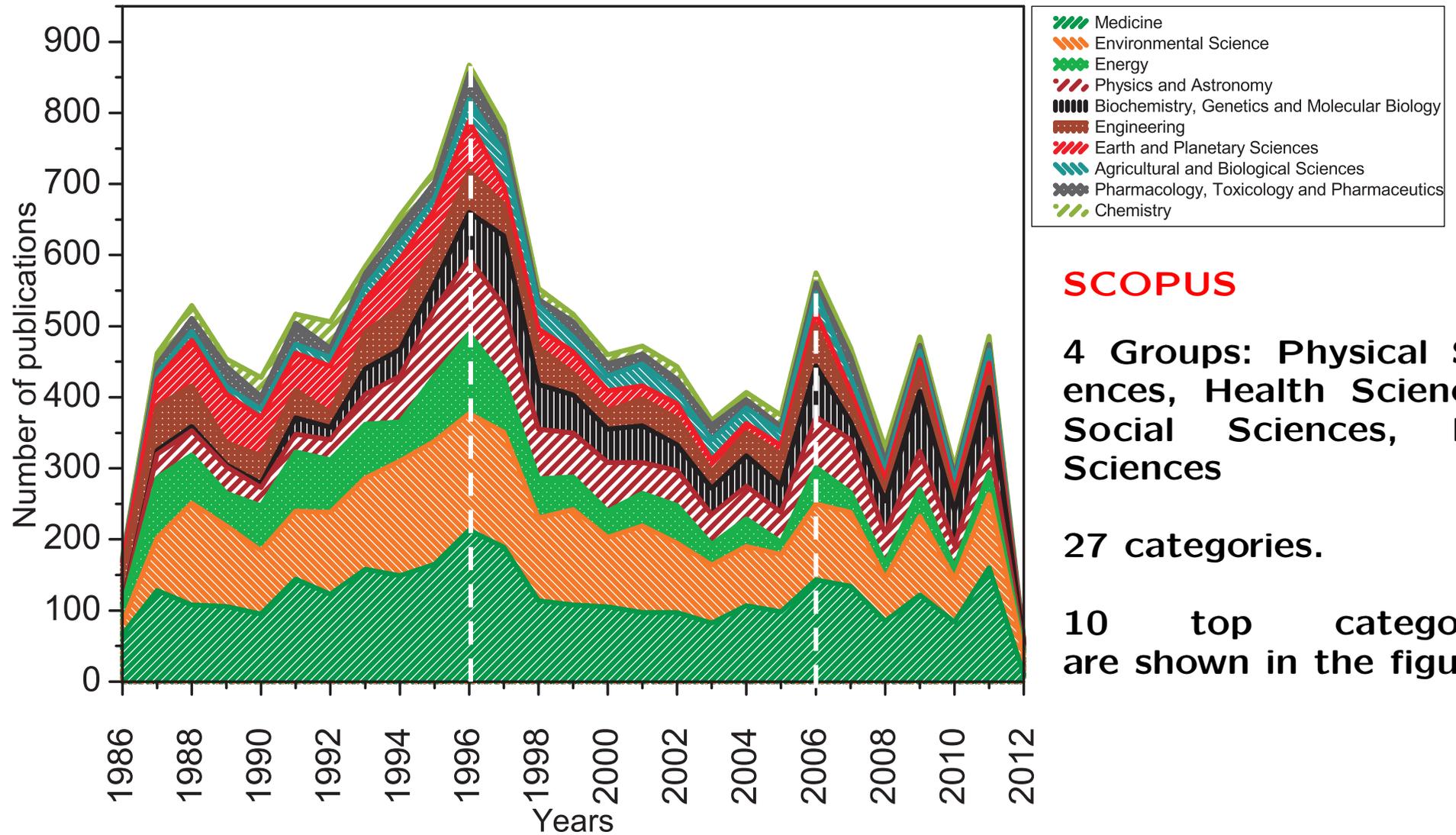
Scopus: 8544 papers,

Ukrainica: 1491 papers

Scopus: <http://www.scopus.com/>

Ukrainica: [www.nbuu.gov.ua/db/ref.html](http://www.nbuu.gov.ua/db/ref.html)

# Multidisciplinary landscapes



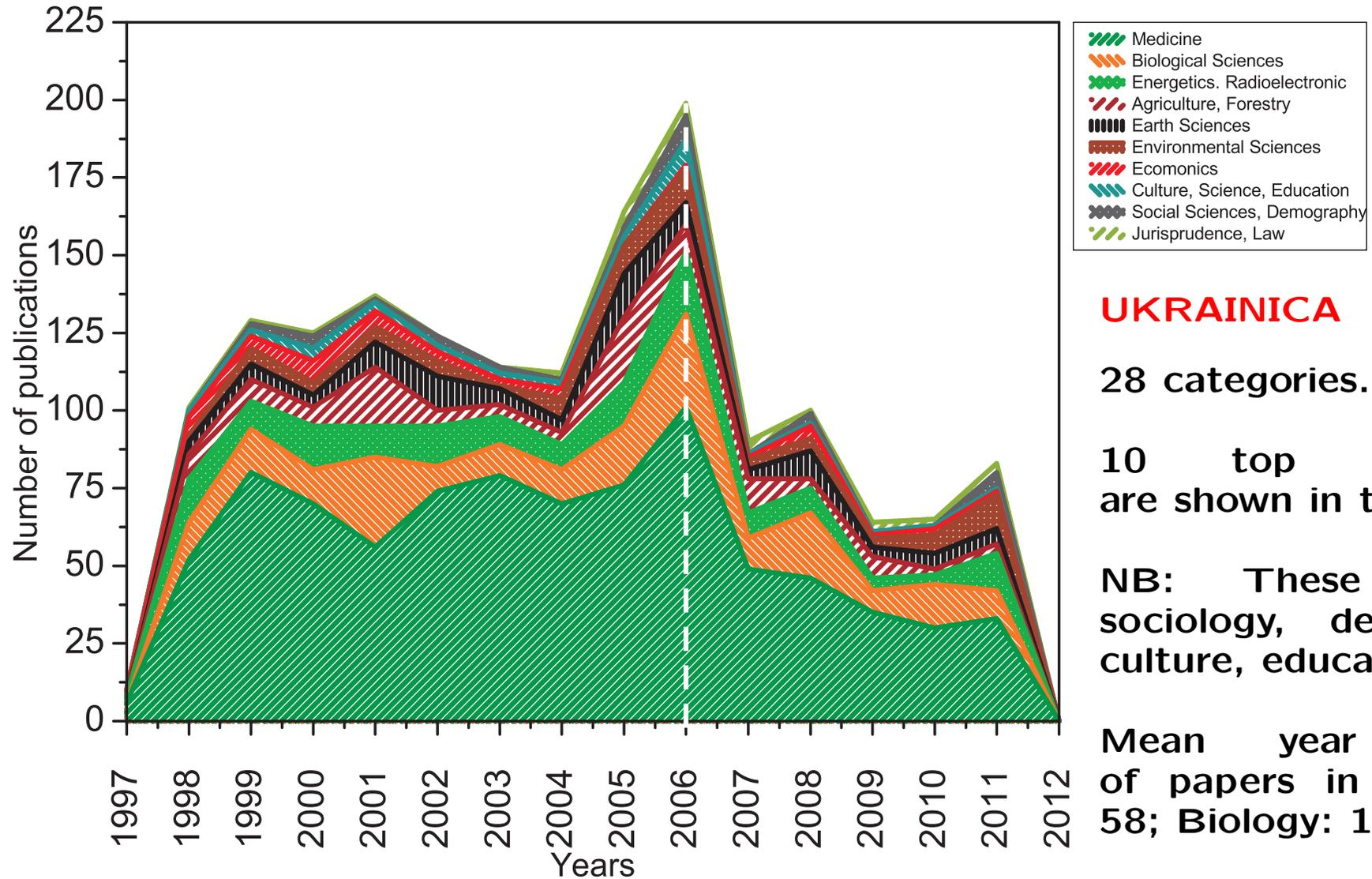
**SCOPUS**

**4 Groups: Physical Sciences, Health Sciences, Social Sciences, Life Sciences**

**27 categories.**

**10 top categories are shown in the figure**

# Multidisciplinary landscapes



**UKRAINICA**

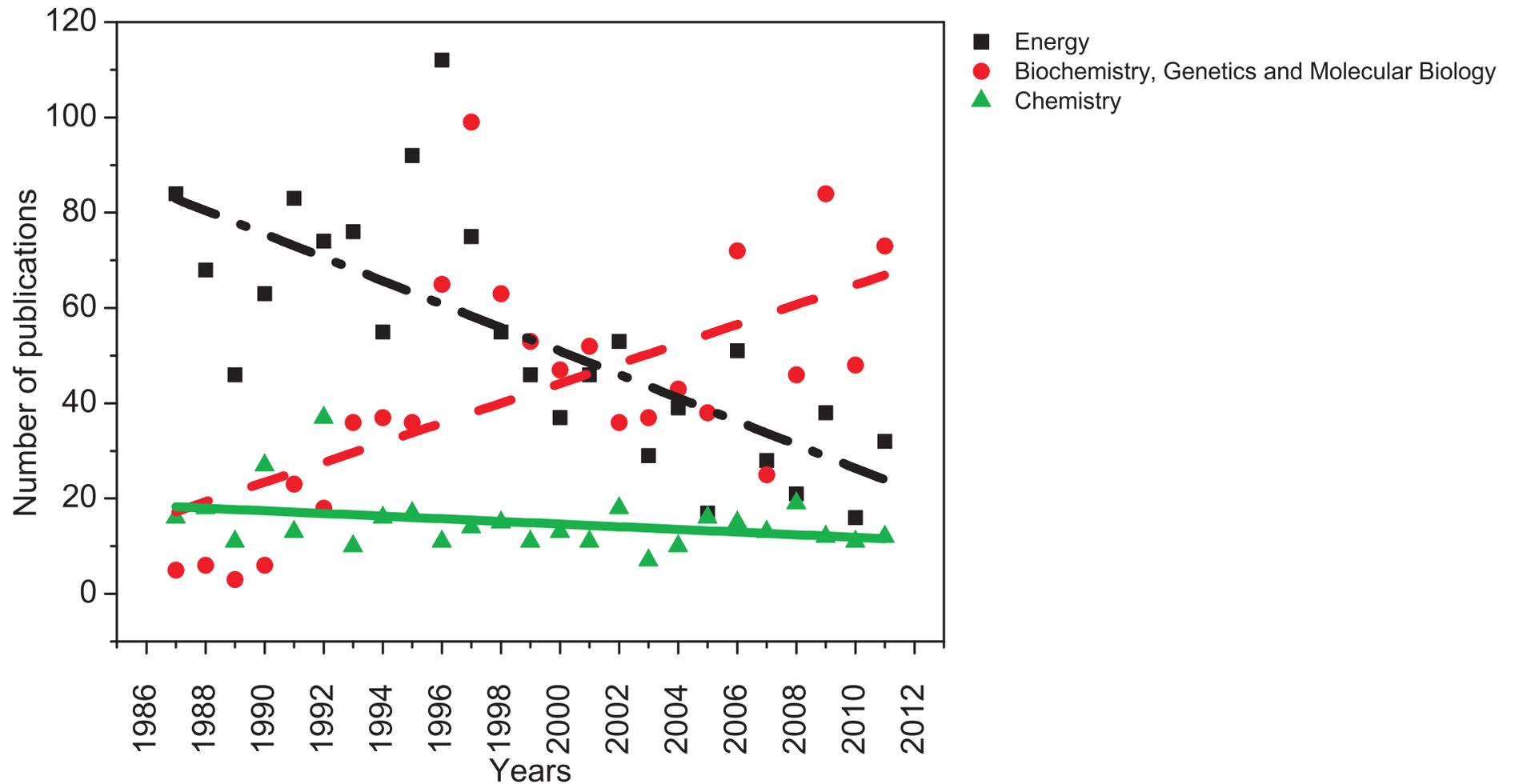
28 categories.

10 top categories are shown in the figure.

NB: These include: sociology, demography, culture, education, law

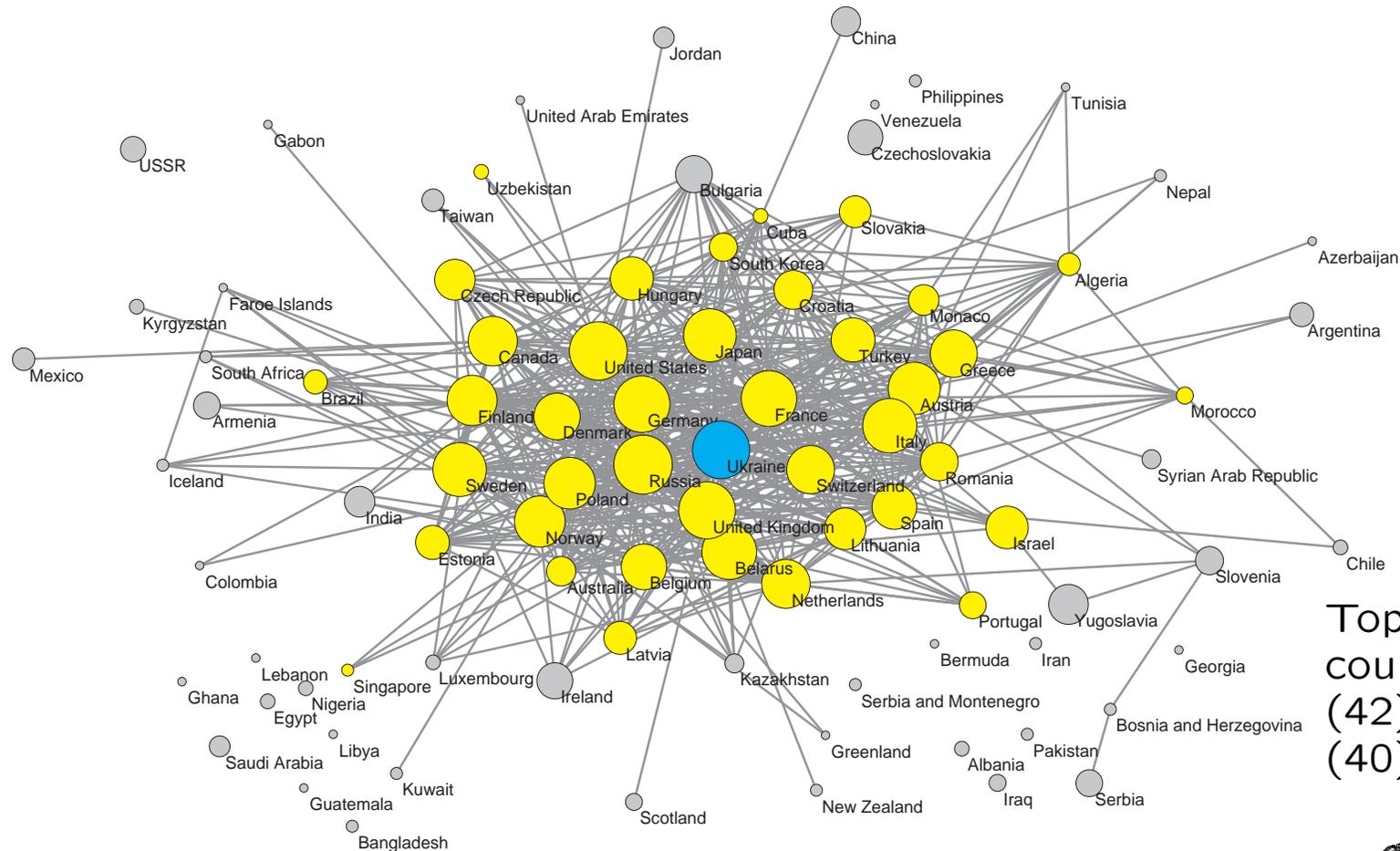
Mean year number of papers in Medicine: 58; Biology: 13.

## Multidisciplinary landscapes



Examples of disciplines with different growth tendencies. ■: Energy; ●: Biochemistry, genetics, and molecular biology; ▲: Chemistry.

# International collaboration



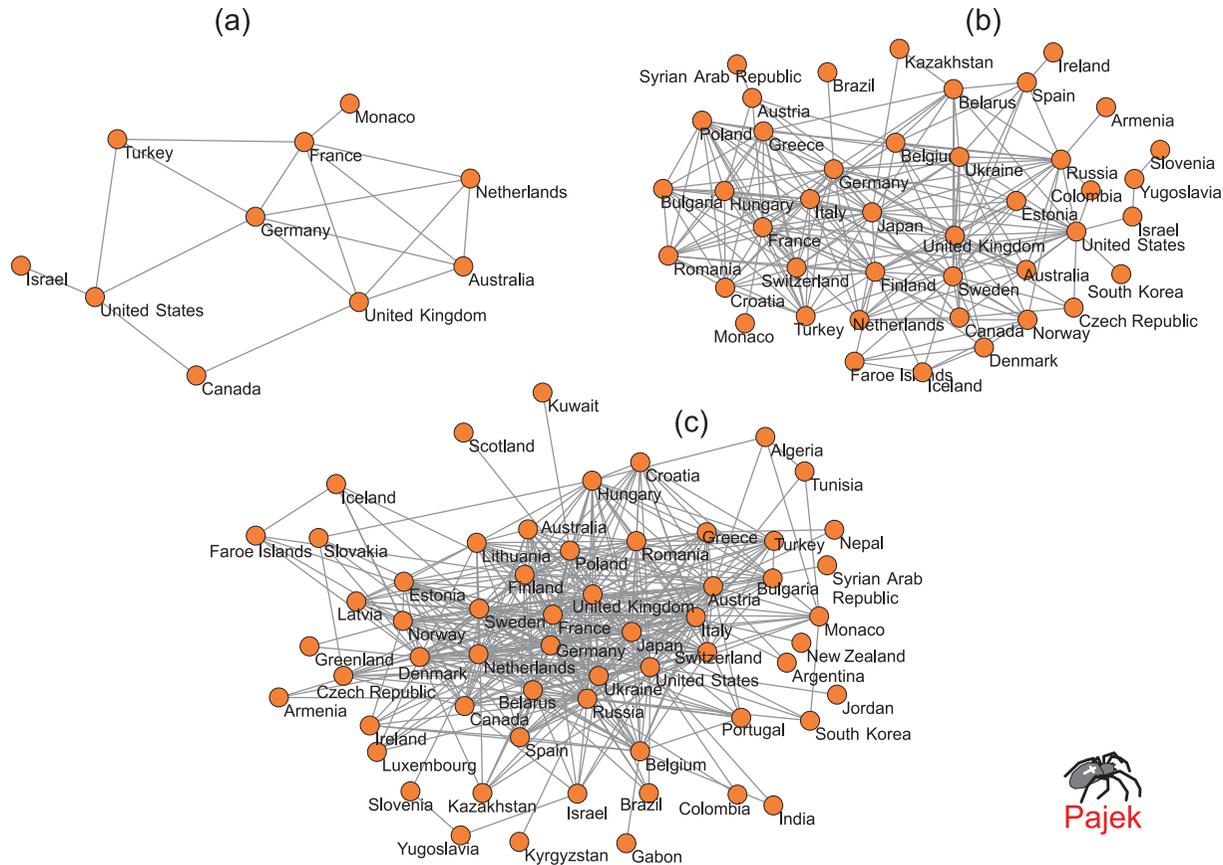
$N = 91$   
 $L = 546$   
 $\langle k \rangle = 12$   
 $k_{\max} = 42$   
 $\langle \ell \rangle = 2.1$   
 $\ell_{\max} = 5$   
 $C = 51$   
 $C/C_r = 3.8$

Top collaborating countries: US, DE (42), RU (41), UA (40), GB, FR (38).



Unweighted network of Chernobyl-related international collaboration (Scopus). Ego-centric (with respect to Ukraine) fragment of the network is shown in yellow.

# International collaboration



Size of the collaboration cluster: 10 (1991), 42 (1996), 56 (2006), 72 (2011).

Top collaborating countries: US, DE (42), RU (41), UA (40), GB, FR (38).



Time evolution of the largest connected component (collaboration cluster): (a) 5, (b) 10, (c) 20 years after the accident.

# Content analysis. Database

**Semantic unit (s.u.)** : a noun phrase consisting of words that are conventionally used together. Here:  $\text{conf}(s.u.) > 0.5$ , where confidence is defined by

$$\text{conf}(\textit{Adjective} + \textit{Noun}) = \frac{P(\textit{Adjective+Noun})}{P(\textit{Noun})}$$

e.g.

$$\text{conf}(\textit{nuclear} \quad \textit{weapon}) = \frac{50}{79} \simeq 0.63$$

$$\text{conf}(\textit{registered} \quad \textit{radiation}) = \frac{3}{940} \simeq 0.002$$

Semantic unit database in different disciplines:

Arts and Humanities	Biochemistry Genetics and Mol. Biology	Energy	Environmental Science	Medicine	Physics
869	7764	7426	13094	15021	7926

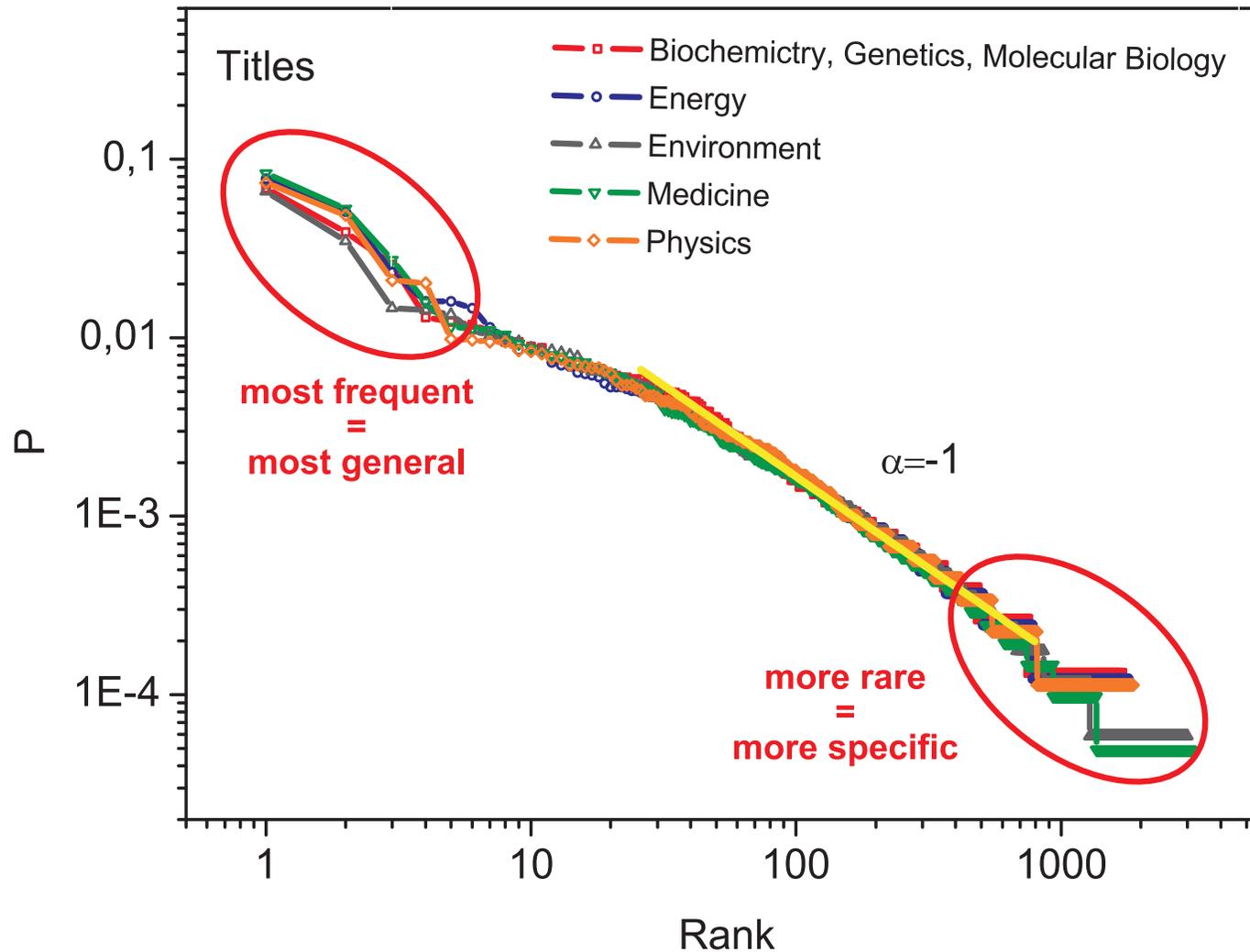
cf. 'collocation' in *C.D. Manning, H. Schütze. Foundations of statistical natural language processing. MIT Press, 1999; s.u. in: N.J. van Eck et al., Scientometrics 82 (2010) 581*

**SCOPUS**, titles & abstracts

Oct. 2013

Document results: 9053

## Semantic unit distribution

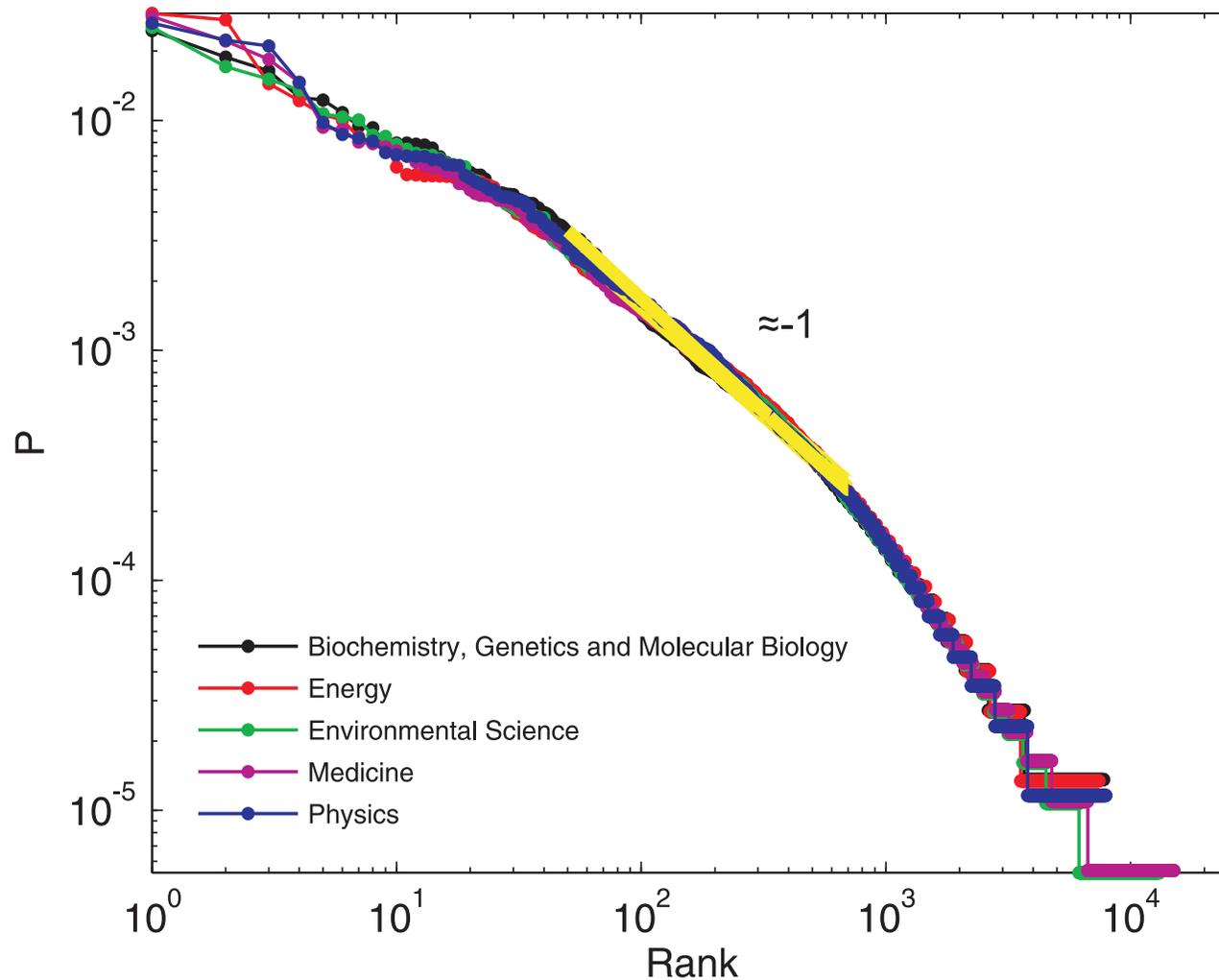


Most frequent:  
Chernobyl, ac-  
cident, dose,  
radiation,  $^{137}\text{Cs}$

Most rare: self-  
diffusion (physics),  
microorganisms  
(environment),  
modified allergen  
(medicine)

'Zipf's law' for s.u. collected from titles: relative frequency  
 $P$  – rank  $r$  dependence,  $\alpha \simeq -1$ .

## Semantic unit distribution

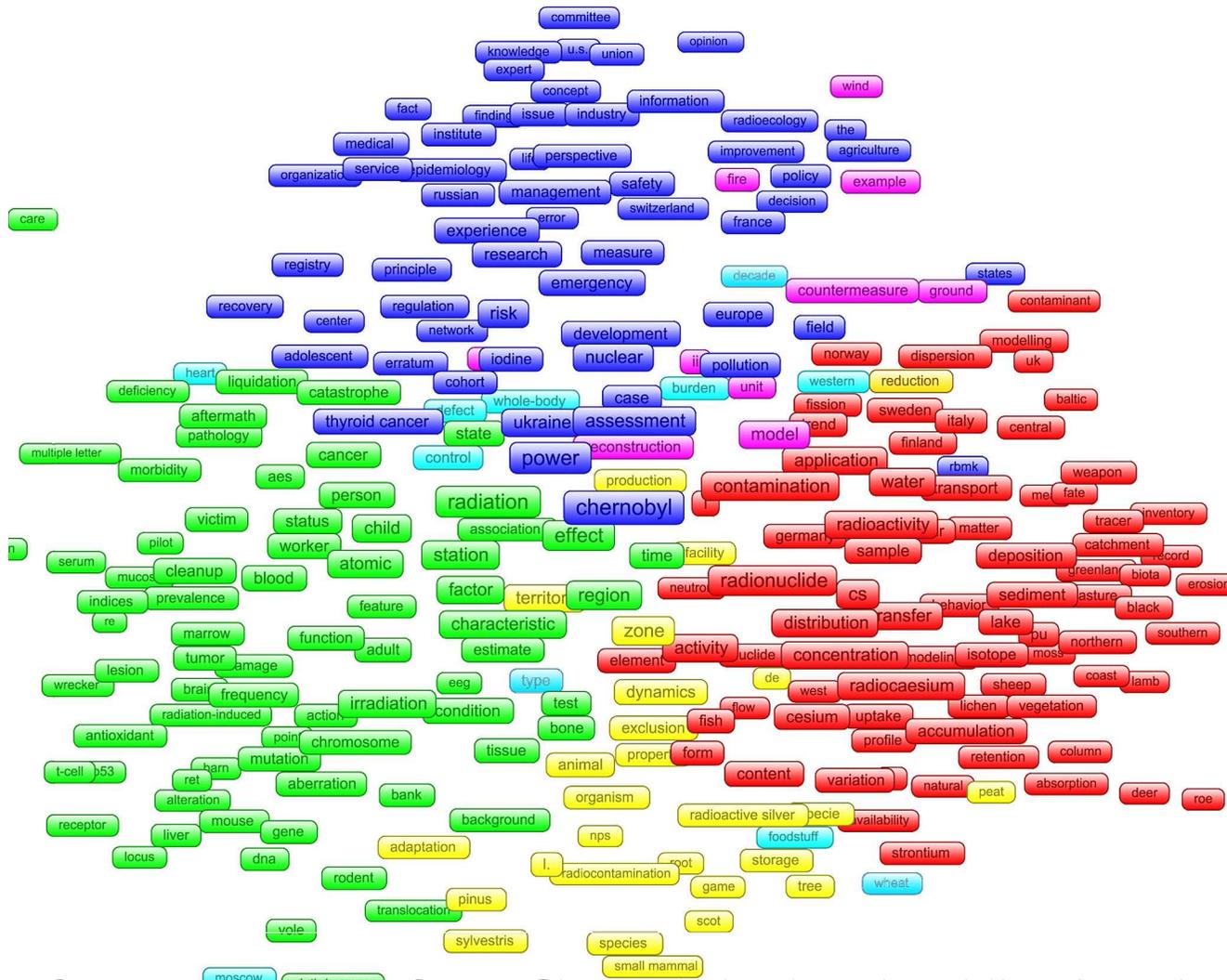


Most frequent: Chernobyl, accident, dose, radiation,  $^{137}\text{Cs}$

Most rare: self-diffusion (physics), microorganisms (environment), modified allergen (medicine)

‘Zipf’s law’ for s.u. collected from titles and abstracts: relative frequency  $P$  – rank  $r$  dependence,  $\alpha \simeq -1$ .

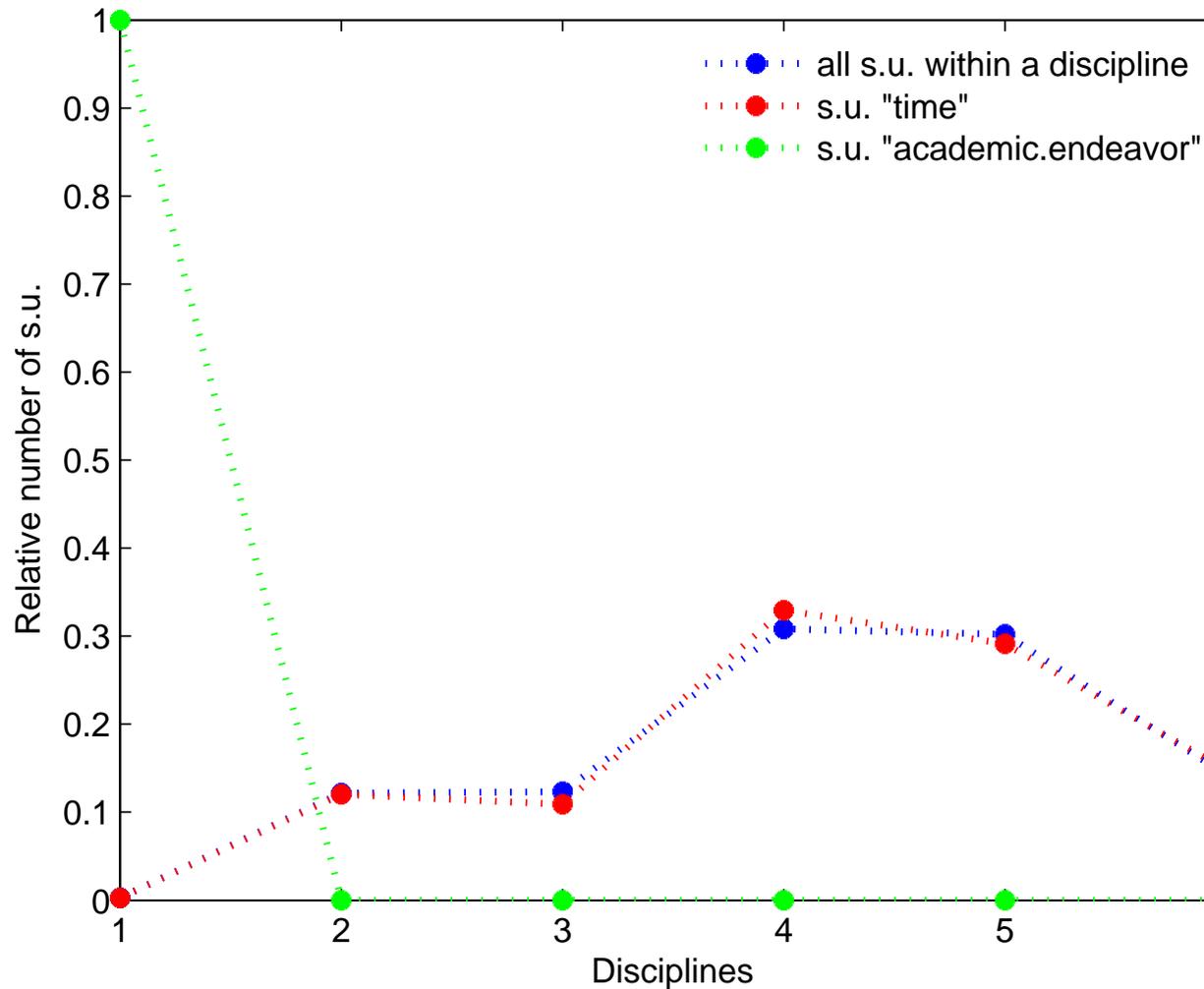
# Semantic unit distribution



Map of semantic units from Chornobyl-related publications in Scopus database (obtained by the *VOSviewer*: <http://www.vosviewer.com/> ).



## Discipline-specific semantic units = terms



A term: a word or a phrase that refers to a domain-specific concept.

Termhood ( $\tau$ ): *K. Kageura, B. Umino, Terminology 3 (1996) 259; N.J. van Eck et al., Scientometrics 82 (2010) 311 :*

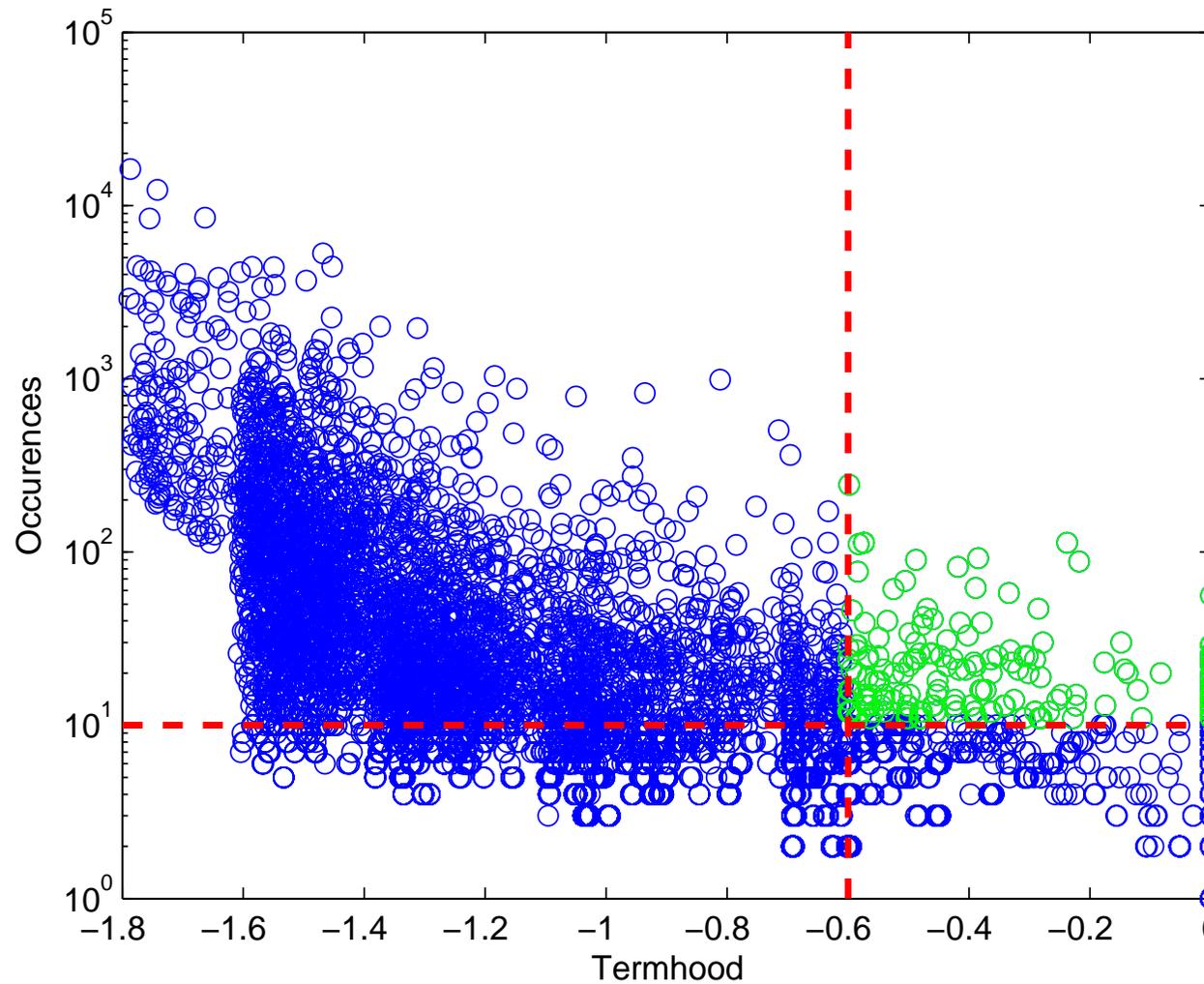
$$\tau(s.u.) = \sum_{j=1}^J p_j \ln p_j,$$

where  $p_j(s.u.) =$

$$\frac{\mathcal{P}_j(s.u.)/\mathcal{P}_j(all)}{\sum_{i=1}^J \mathcal{P}_i(s.u.)/\mathcal{P}_i(all)}$$

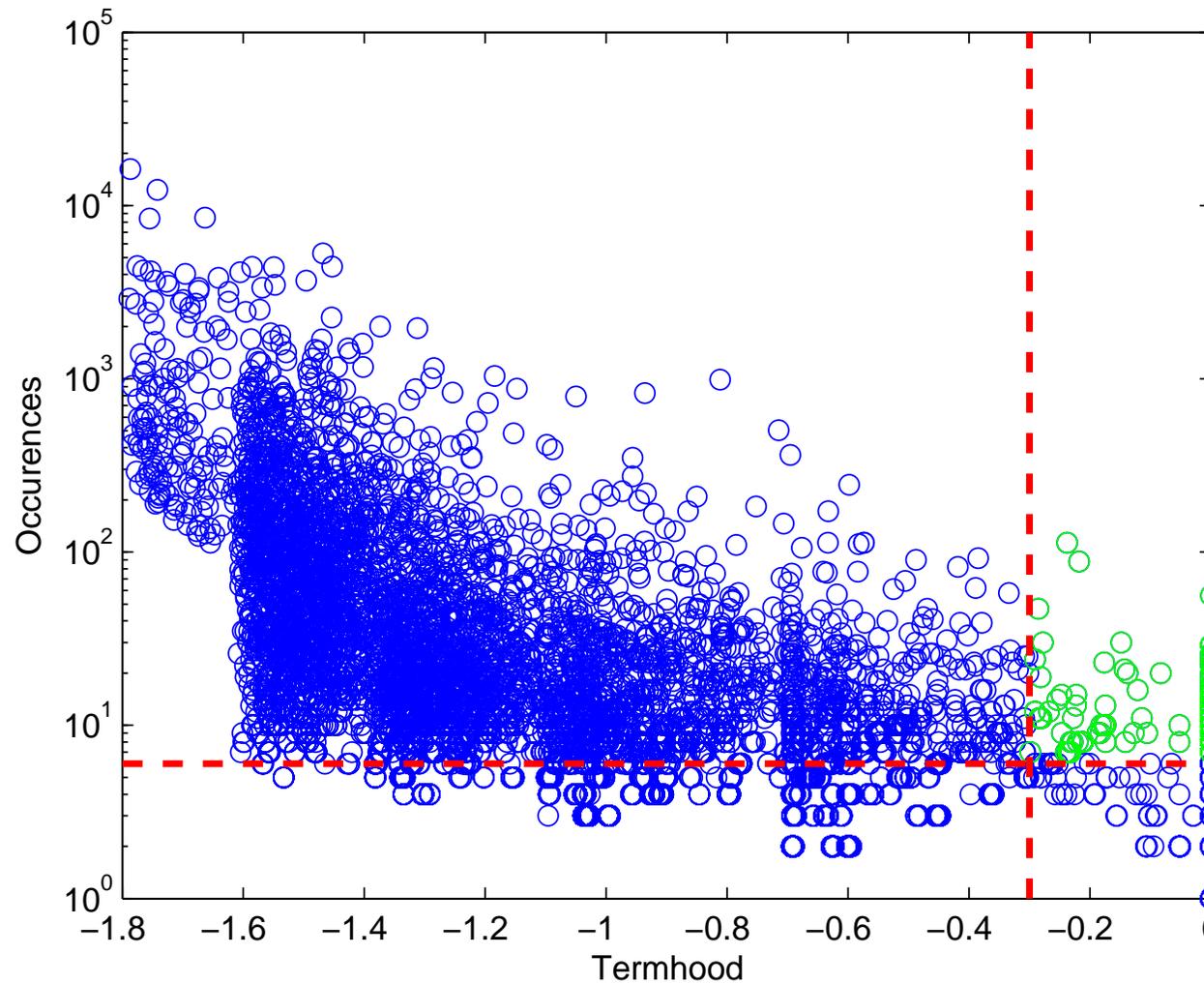
Relative number  $\mathcal{P}$  of s.u. occurrences within different disciplines. 1: Arts and Humanities, 2: Biochemistry, Genetics and Mol. Biology, 3: Energy, 4: Environmental Science, 5: Medicine, 6: Physics.  $\tau(\bullet) = -1.78$ ,  $\tau(\bullet) = 0$ .

## Discipline-specific semantic units = terms



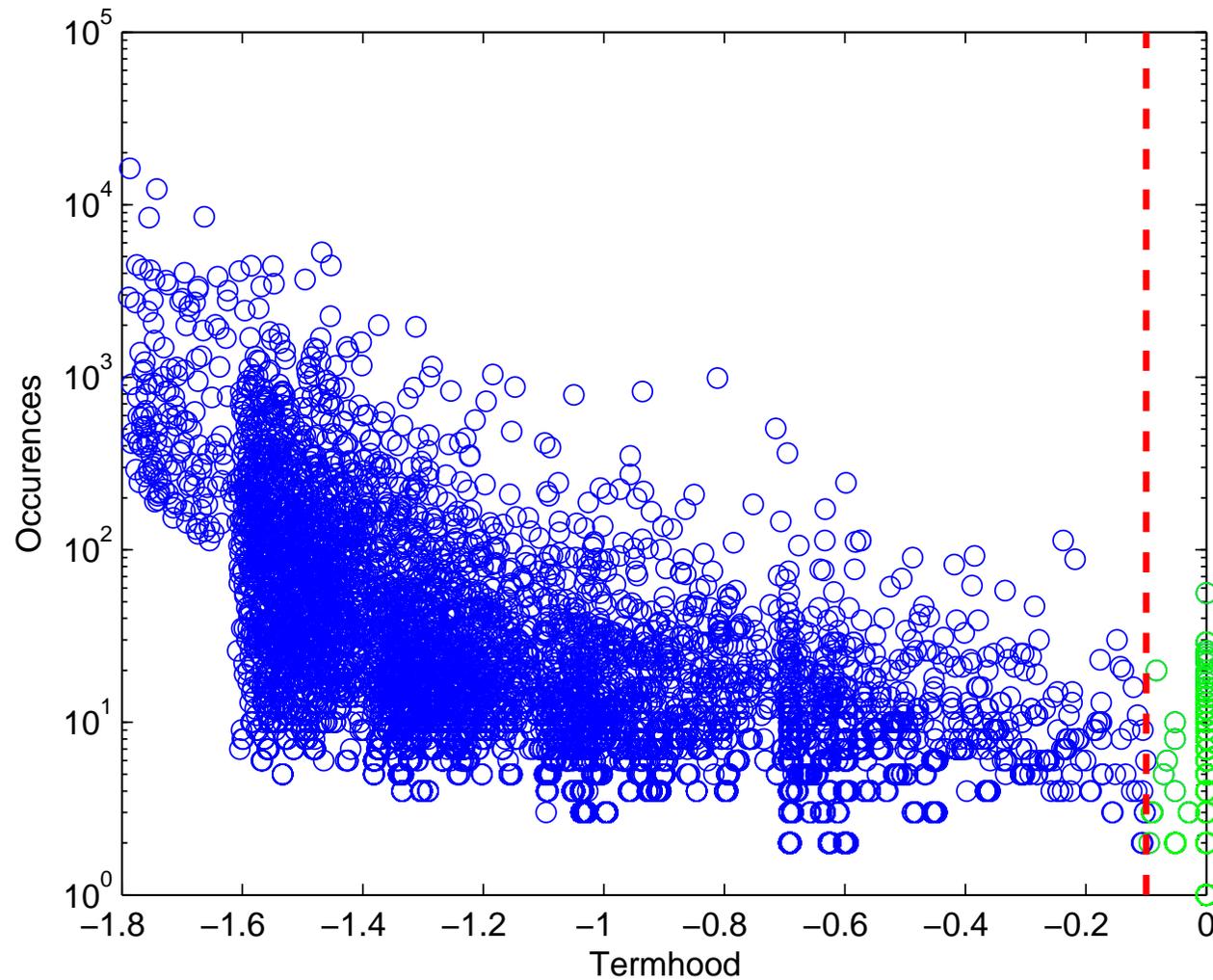
Scatter plot of all semantic units showing their # of occurrences in all disciplines versus termhood. Green circles: # > 10, termhood > -0.6.

## Discipline-specific semantic units = terms



Scatter plot of all semantic units showing their # of occurrences in all disciplines versus termhood. Green circles: # > 6, termhood > -0.3.

## Discipline-specific semantic units = terms



Scatter plot of all semantic units showing their # of occurrences in all disciplines versus termhood. Green circles: termhood  $> -0.1$ .

## Conclusions and outlook

- Chernobyl-related topics still pose problems of scientific interest.
- Along with dominant medicine or environmental studies, one observes scientific fields where active studies increase (genetics, physics).
- Gradually, Ukraine became well-integrated into the international research on Chernobyl-related subjects. Besides 'universal' spheres of medicine, biology, energy Ukrainian researches analyze specific topics of culture, arts, law.
- One observes peaks in publications caused by 'jubilee' effect.
- Outlook: content analysis of the accumulated database.