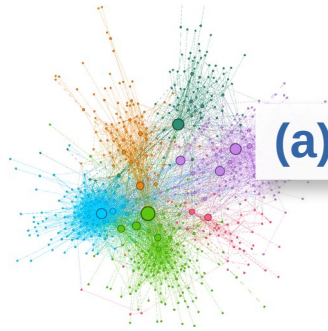
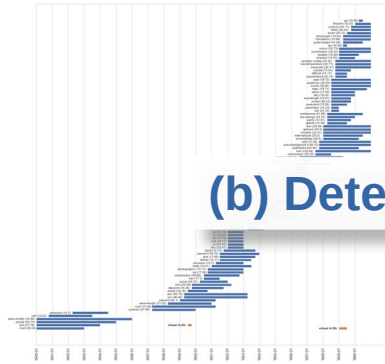
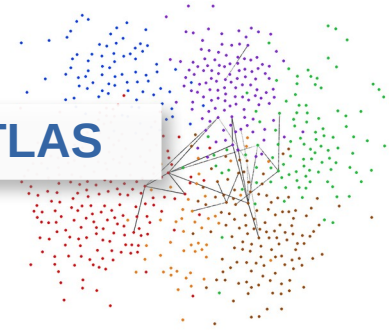


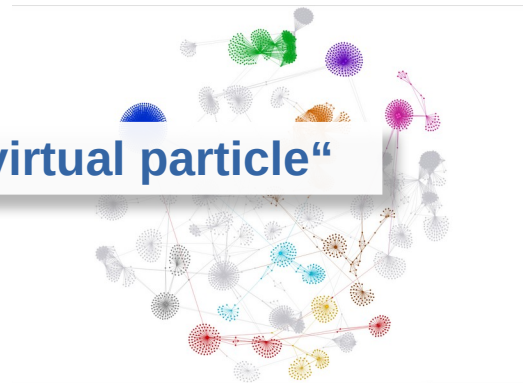
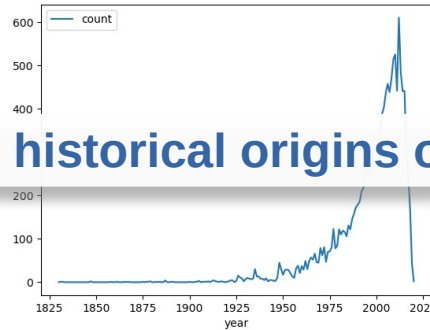
A1 report (I): Digital methods for LHC epistemology and the study of concept formation



(a) Analysis of email-communication in ATLAS



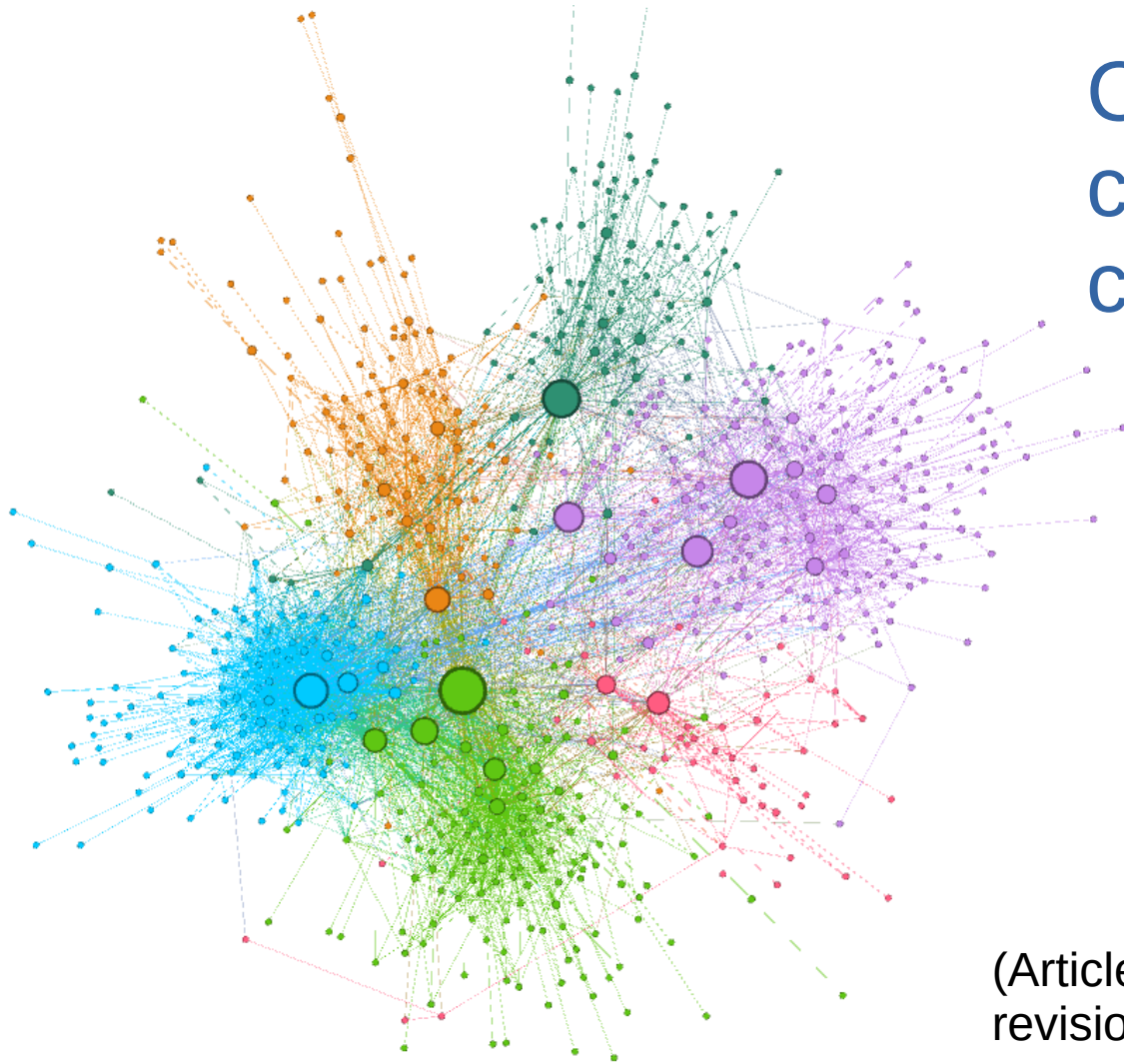
(b) Detecting the historical origins of the „virtual particle“



Adrian Wüthrich (student assistant: Michael Zichert)

(a) Analysis of email-communication in ATLAS

Characterizing a collaboration by its communication structure

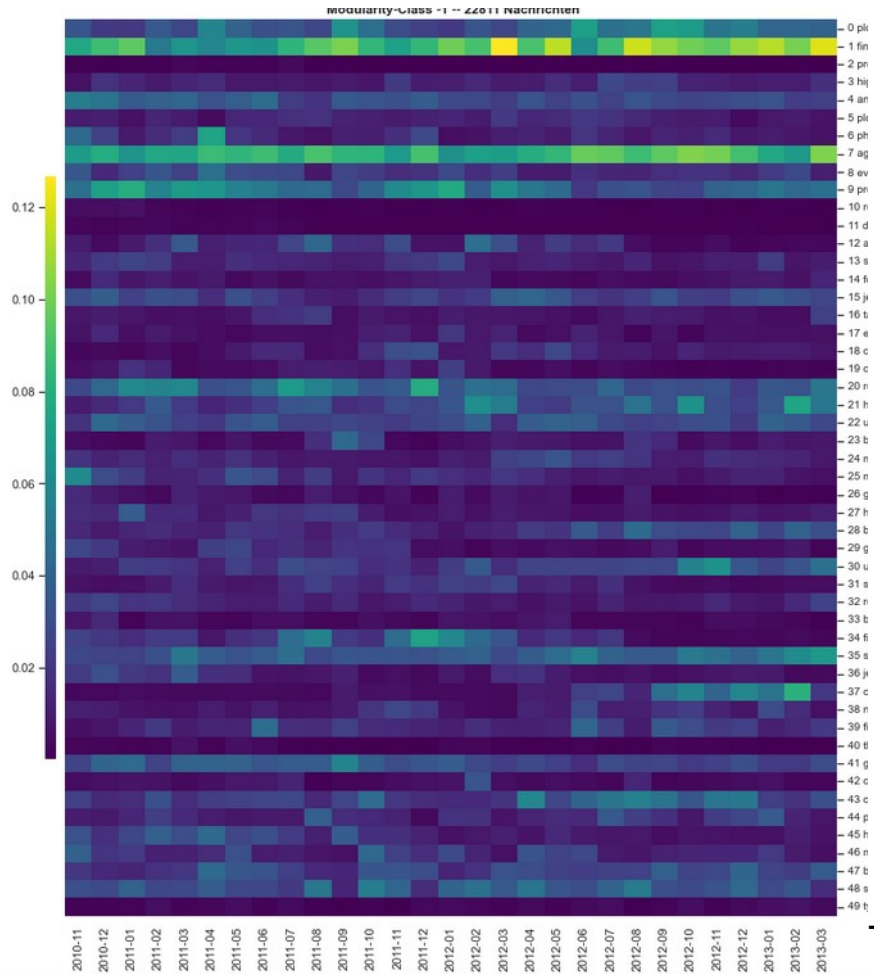


ATLAS email network
(2010-2013)

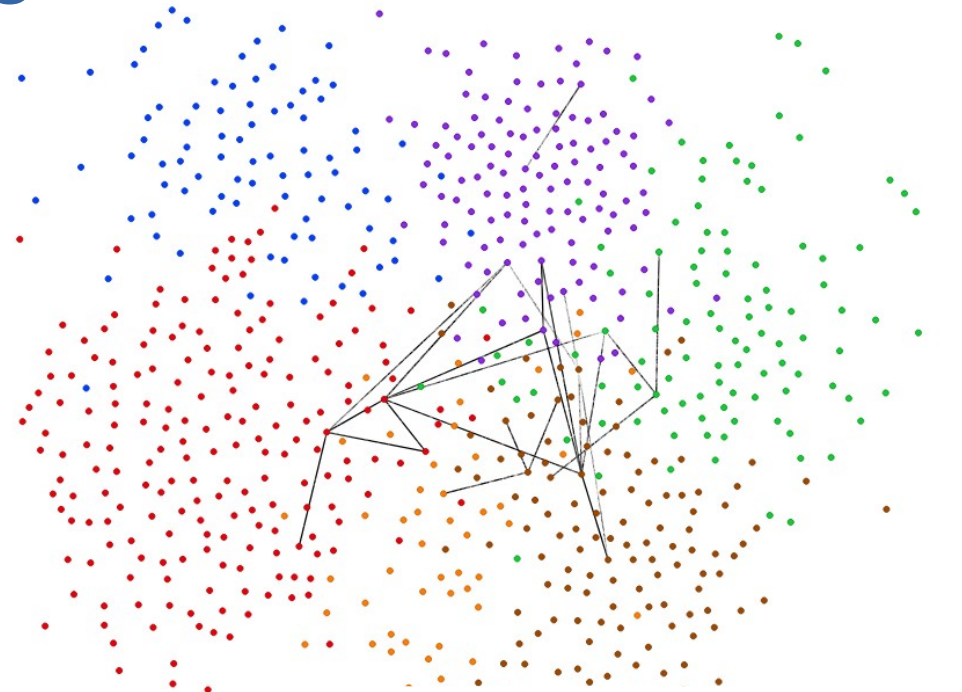
- Dense
- Clustered/transitive
- Group structure
- Not assortative

(Article under review after major revisions for *Synthese*.)

The „humming“ of ATLAS



Weights of topics over time



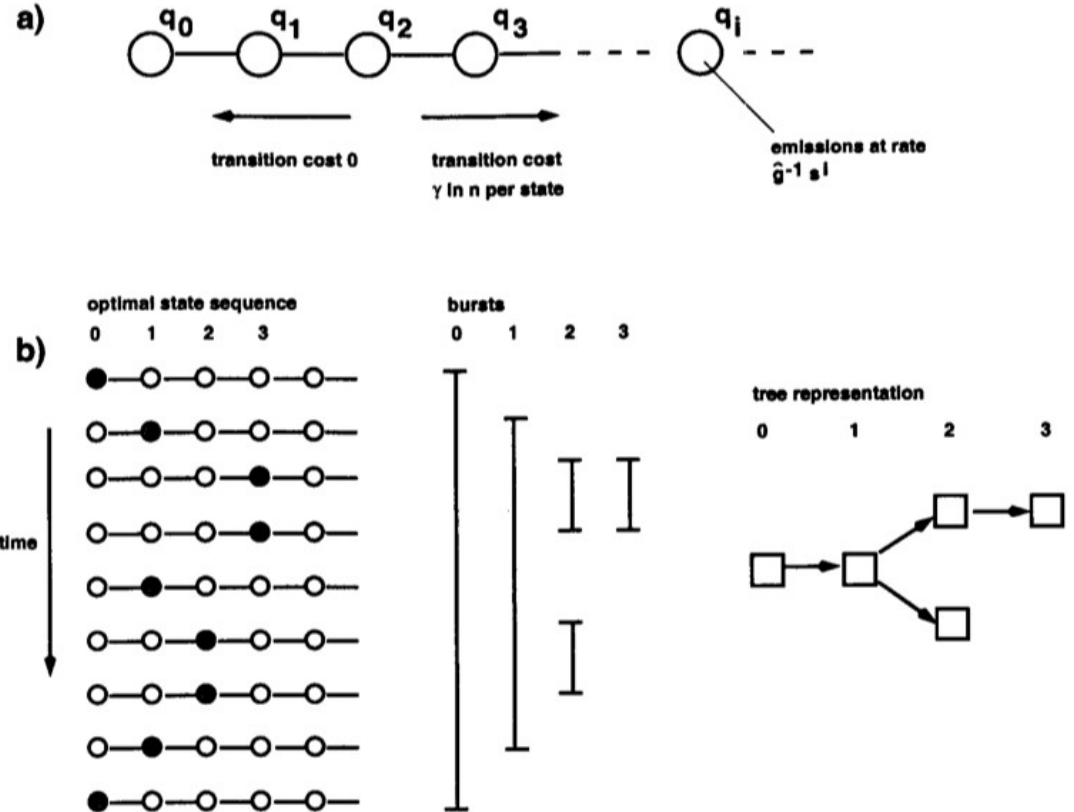
Topic modelling by „latent Dirichlet allocation“ (Blei et al. 2003)

(b) Detecting the historical origins of the „virtual particle“

Exploration of different approaches:

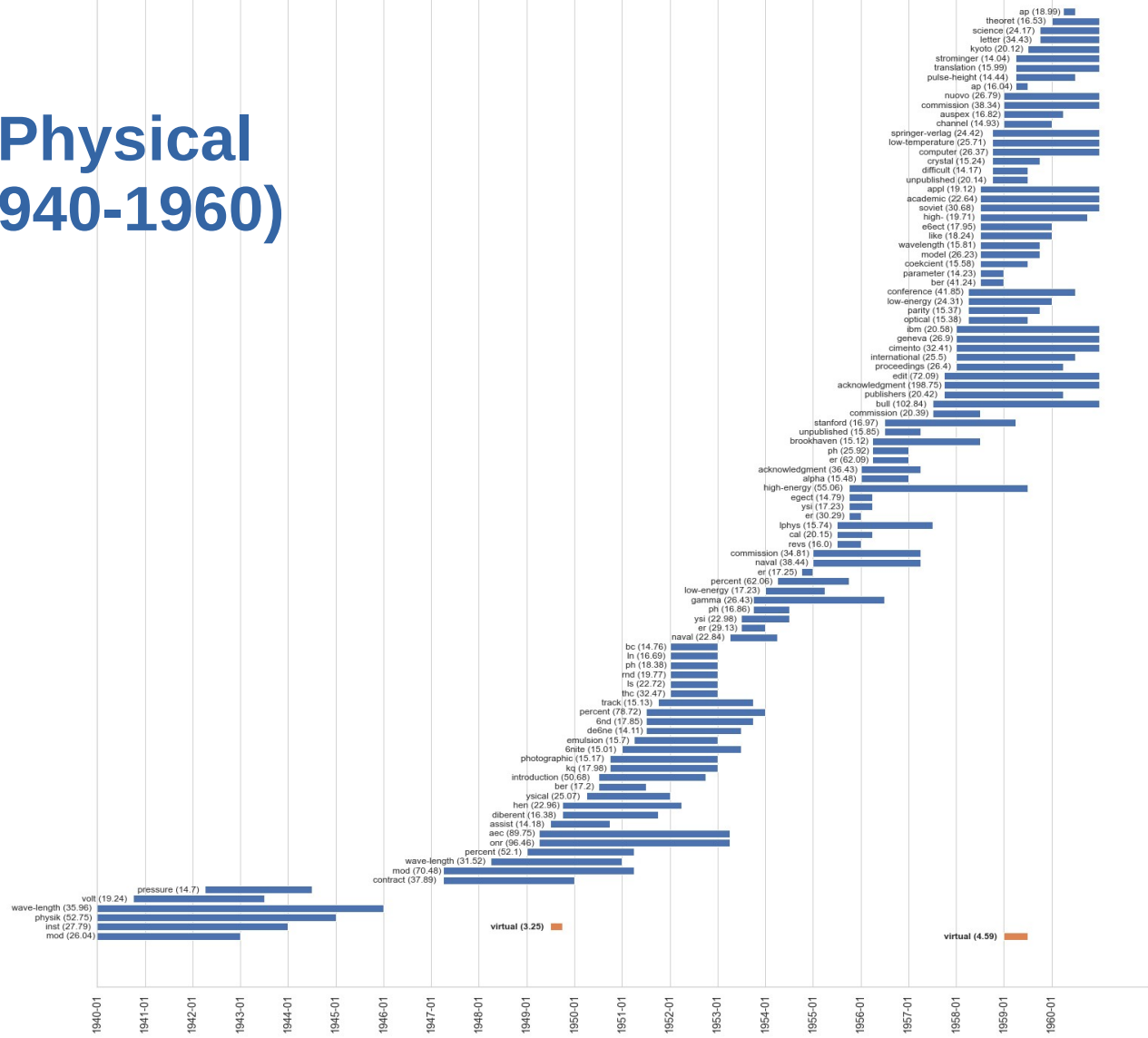
- Burst detection
- Referenced publication years spectroscopy
- Co-citation analysis

Burst detection



- Kleinberg (2002)
- More significant patterns than mere increase or decrease in frequency
- Automaton model:
 - Transitions between states
 - Cost of transition
 - Inertia

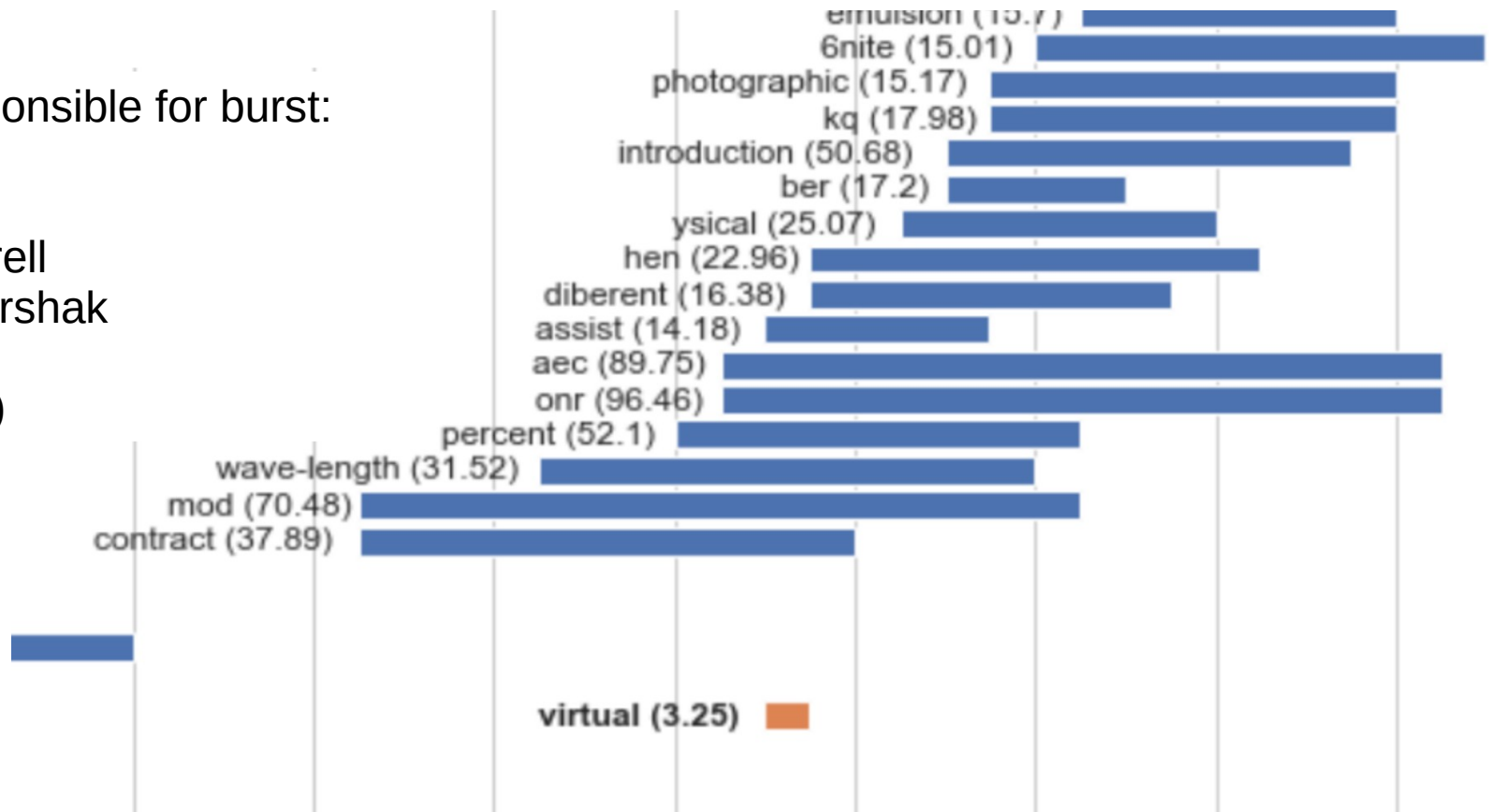
Bursts in Physical Review (1940-1960)



First burst of „virtual“ (1949)

Authors responsible for burst:

- Bethe
- Dancoff/Drell
- Ashkin/Marshak
- Etc.
- (Feynman)



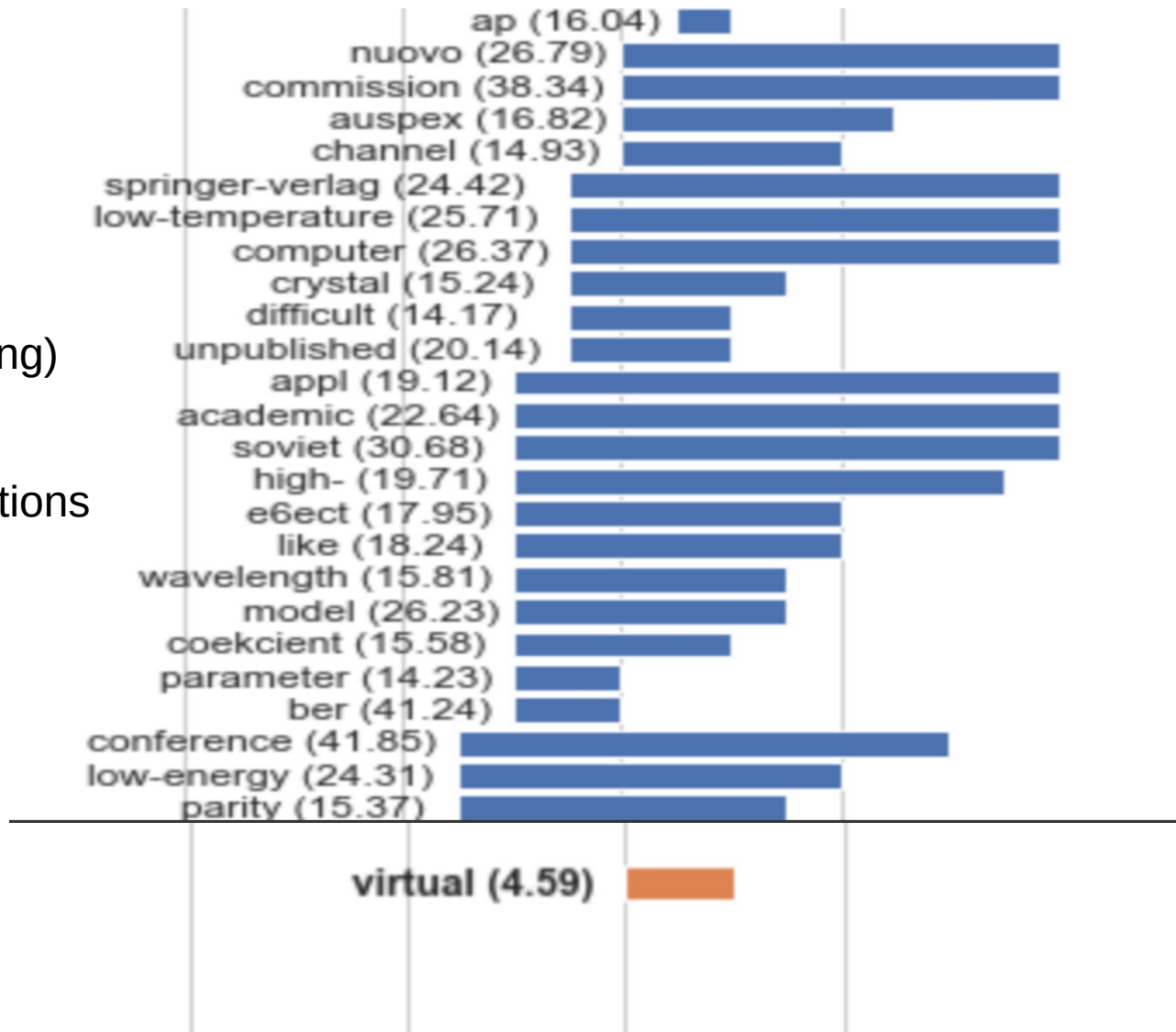
Second burst of „virtual“ (1959)

Article topics (close reading) responsible for burst:

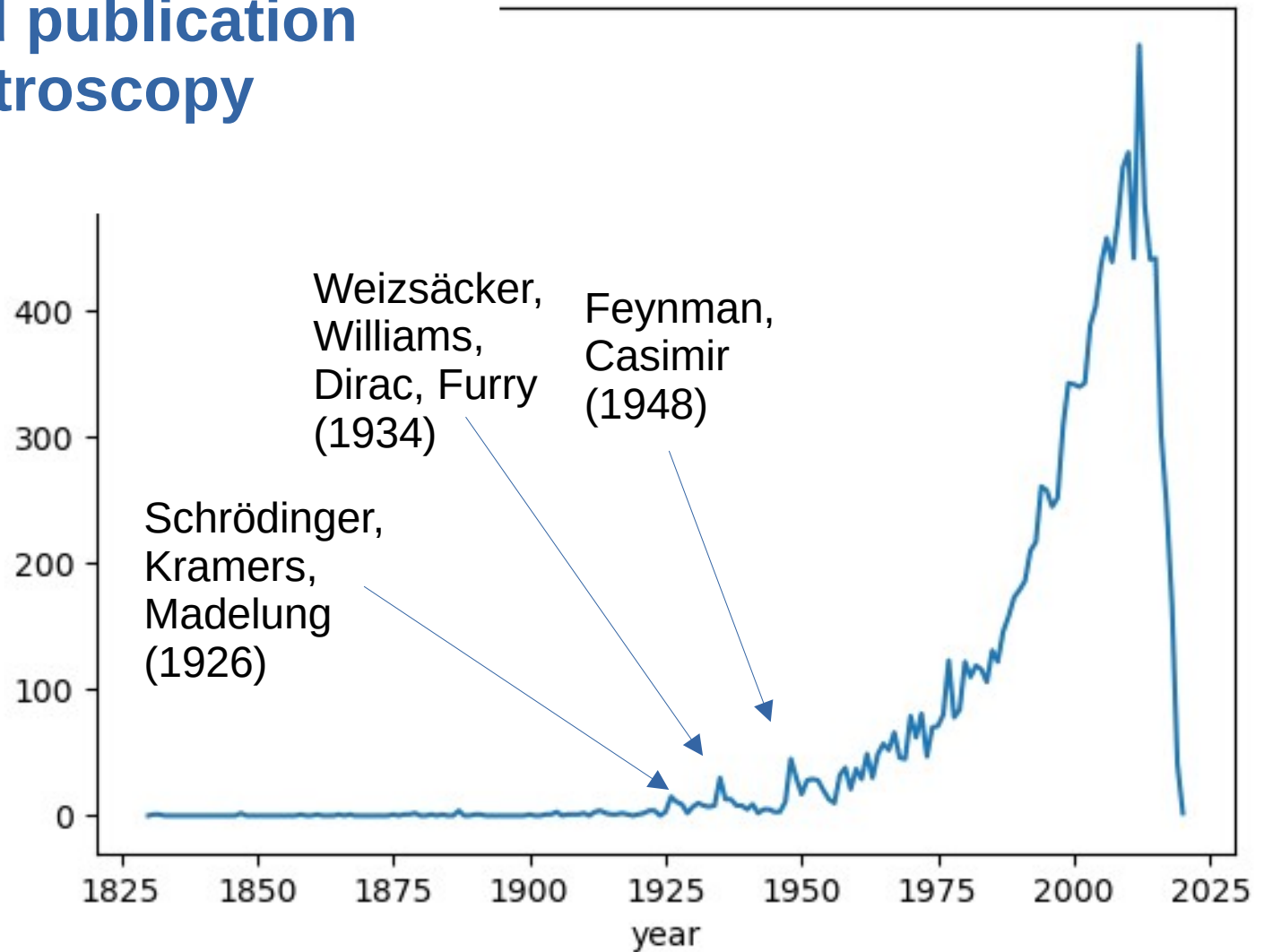
- Electromagnetic corrections
- Hyperfine structure
- Dispersion relations

Authors:

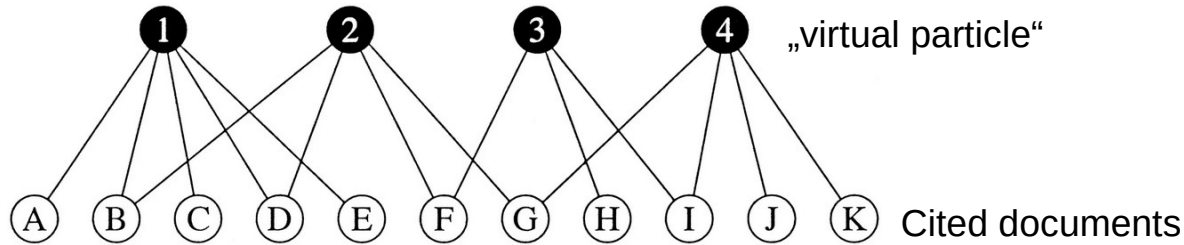
- Breit
- Drell/Fubini
- Watson
- Etc.



Referenced publication years spectroscopy (RPYS)



Co-Citation analysis



Why?

- „Intellectual base“ (Persson 1994)
- Not tied to the term
- Base → Origins?
- Temporal dynamics?
- Transfer from one field to the other?
- Brokers?
- (Application to DM-MOND debate?)

How?

- Web of Science
- *metaknowledge* and *networkx*
- Topic modelling of abstracts (*gensim*, *mallet*)
- Term-frequency/inverted document frequency („tf-idf“, *scikit-learn*)
- Keywords, journals, „central“ authors
- Close reading, background knowledge

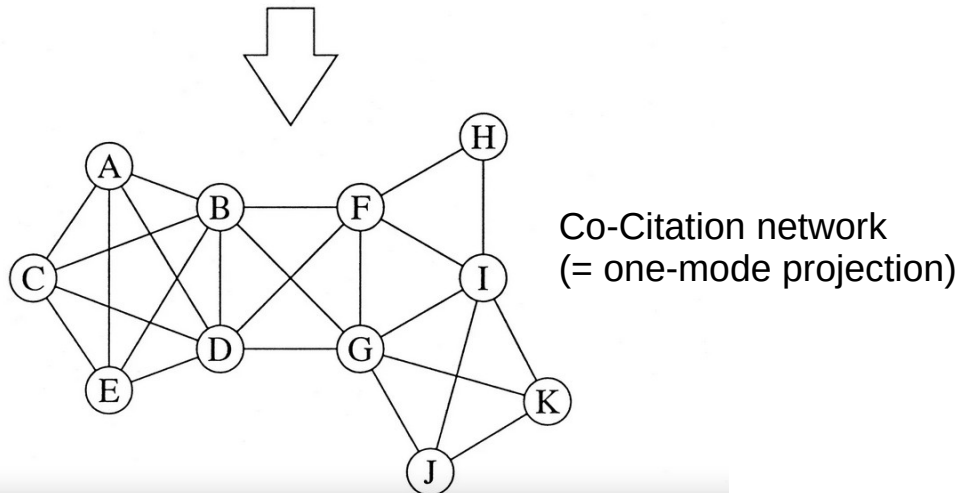
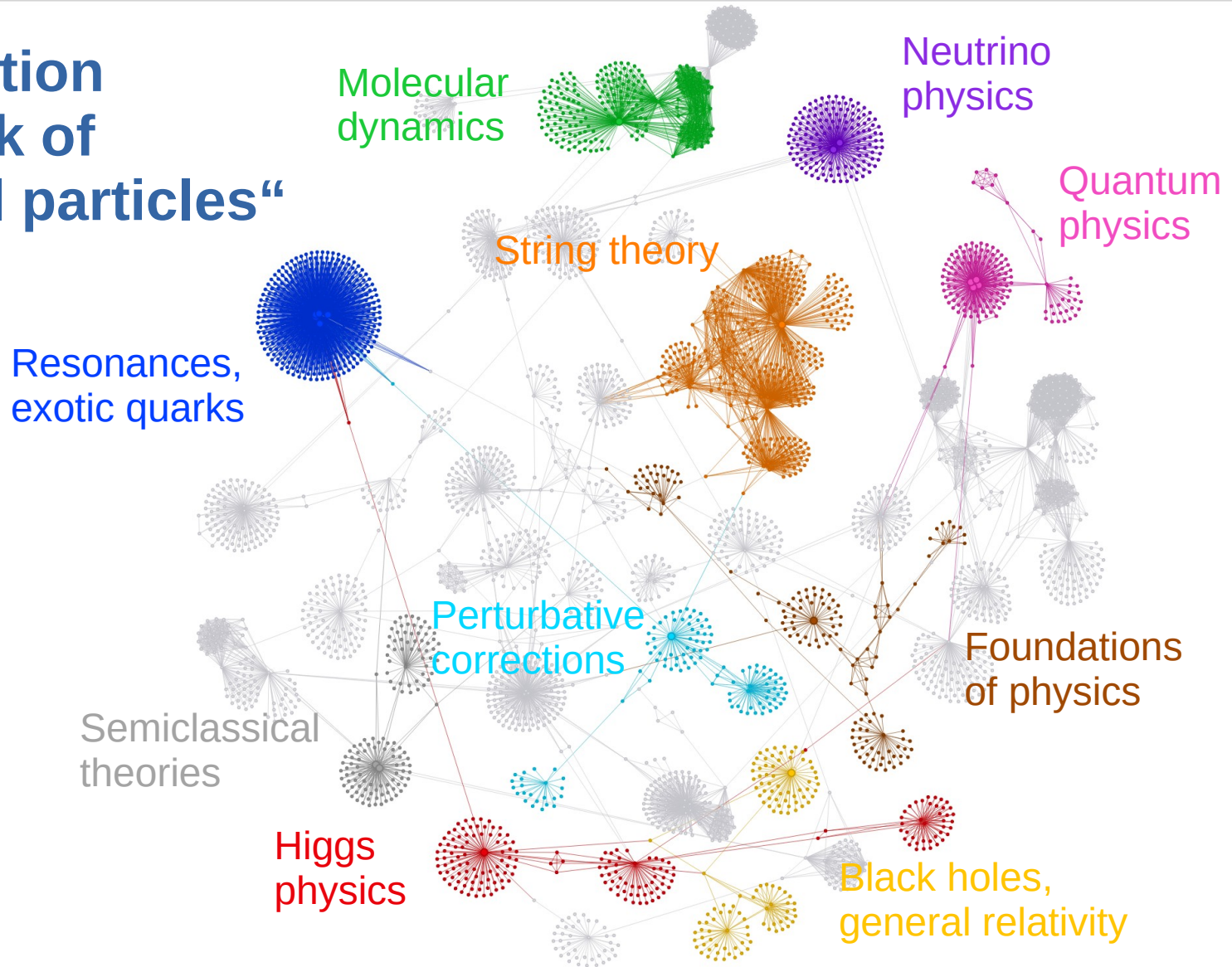


Image: Newman/Weingart

Co-citation network of „virtual particles“



Summary

- Paper under review on ATLAS' communication structure
- Work in progress: topic modelling the email communication of ATLAS
- Exploration of several digital approaches to identifying historical origins of the concept of the virtual particle:
 - Bursts
 - Reference publication years spectroscopy
 - Co-Citation analysis (combined with topic-modeling, tf-idf etc.)