Evolution of the social network of scientific collaborations

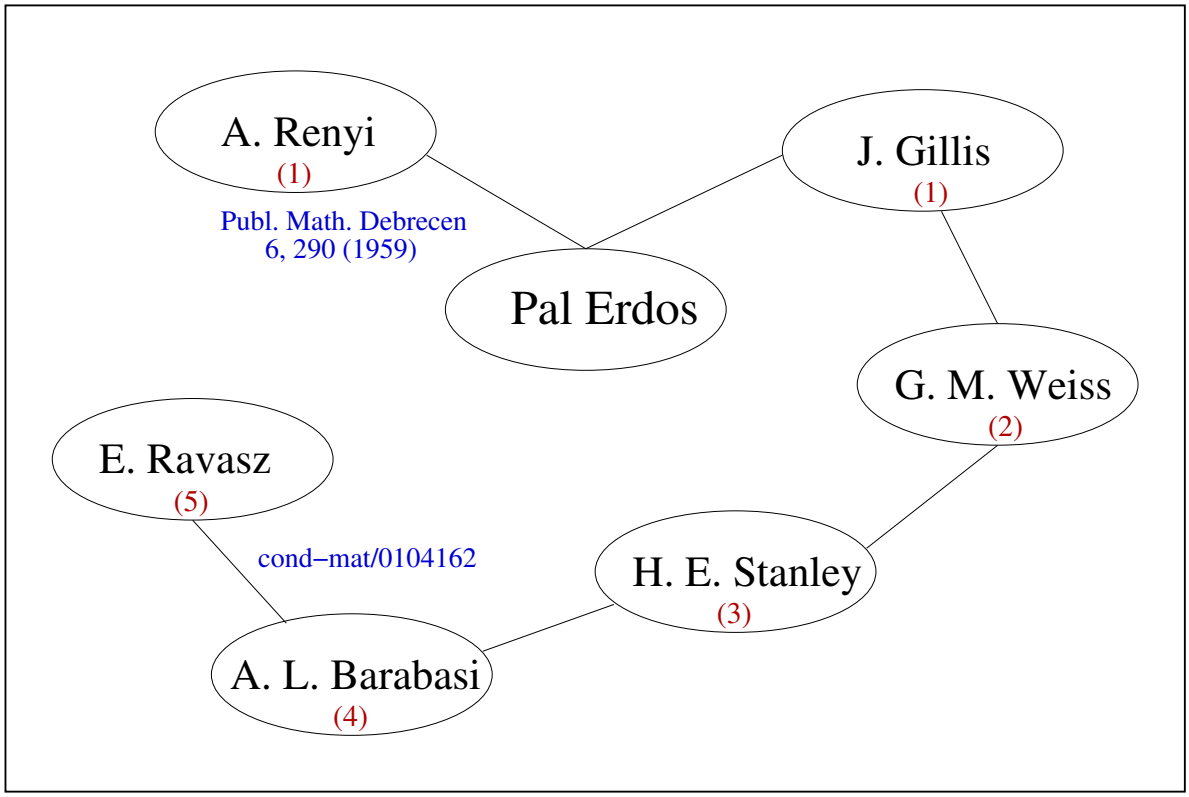
Erzsébet Ravasz
University of Notre Dame

A.L. Barabási, H. Jeong, Z. Néda,
A. Schubert, T. Vicsek

cond-mat/0104162
http://www.nd.edu/~networks

Outline

- What is the **Erdős number** ?

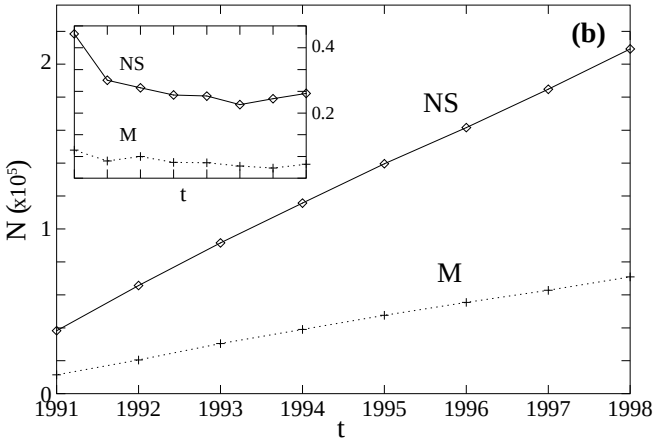


- Why the coauthorship network?
  - size matters
  - history also matters

Modeling the Web of Science

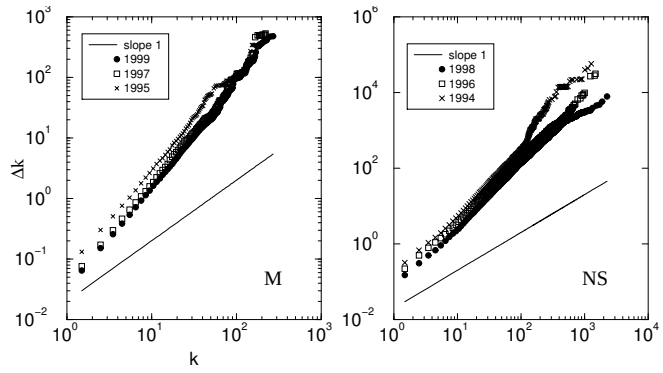
- Incoming authors
  - join at constant rate:

$$N(t) = \beta\, t$$

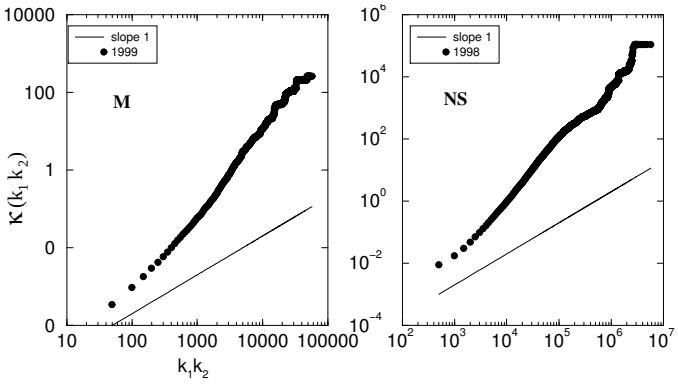


  - follow preferential attachment

$$\Pi_i = b\,\frac{k_i}{\sum_j k_j}$$



- New collaborations
  - internal preferential attachment



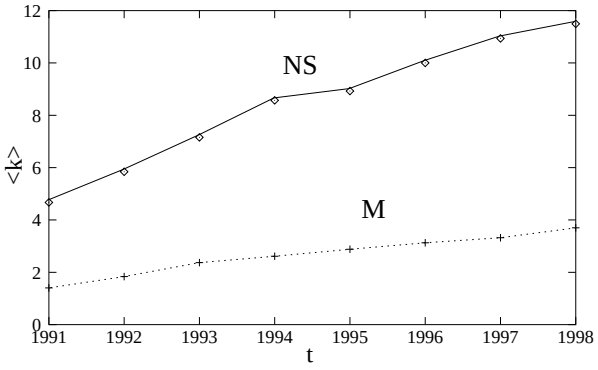
$$\Pi_{ij} = 2\,N(t)\,a\,\frac{k_i\,k_j}{\sum'_{sm} k_s\,k_m}$$

Continuum Theory

- Master Equation of the model

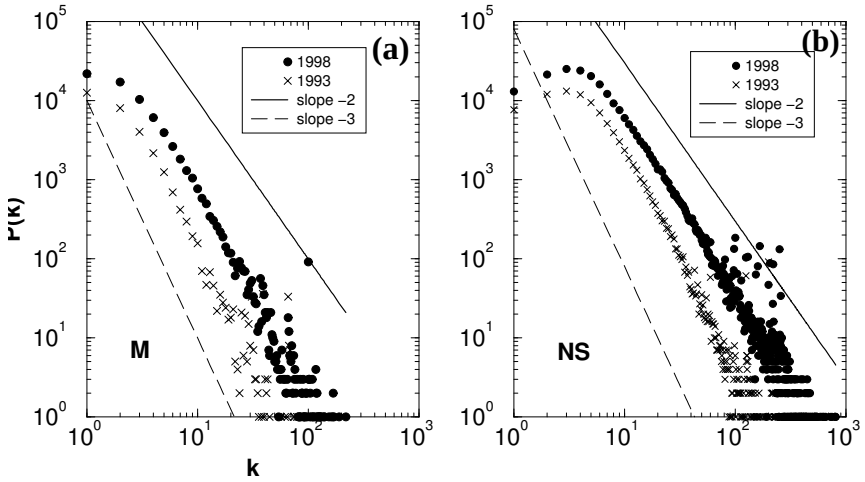
$$\frac{dk_i}{dt} = \frac{b\beta k_i}{\sum_j k_j} + 2\,N(t)\,a \sum_j{}' \frac{k_i k_j}{\sum'_{s,m} k_s k_m}$$

- $< k > = at + 2b$



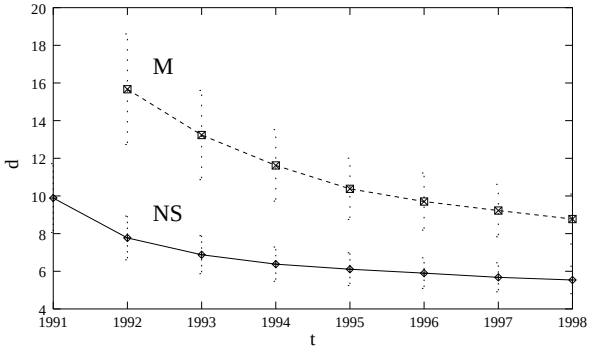
- $k_c = b\sqrt{t(2+\alpha t)^3}$
- $t \to \infty \;\Rightarrow\; \gamma \to 3/2$
- $k \ll k_c \;\Rightarrow\; P(k) \propto k^{-3/2}$

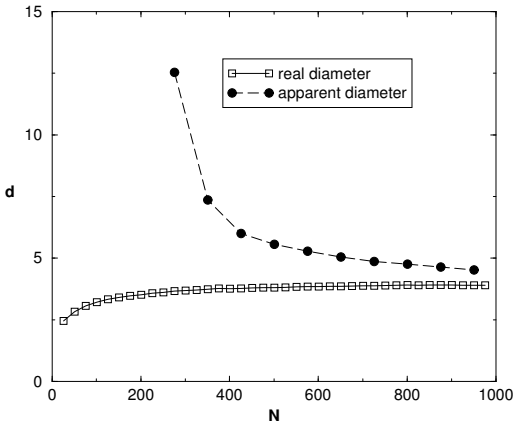
  $k \gg k_c \;\Rightarrow\; P(k) \propto k^{-3}$



- **Degree distribution of the coauthorship networks**

Monte Carlo Simulation of the Model





- **Real and apparent average path length**

- Measured preferential attachment:

  $\Pi_i = b \frac{k_i^\nu}{\sum_j k_j^\nu}$ with $\nu \approx 0.8$

- Solvable model:

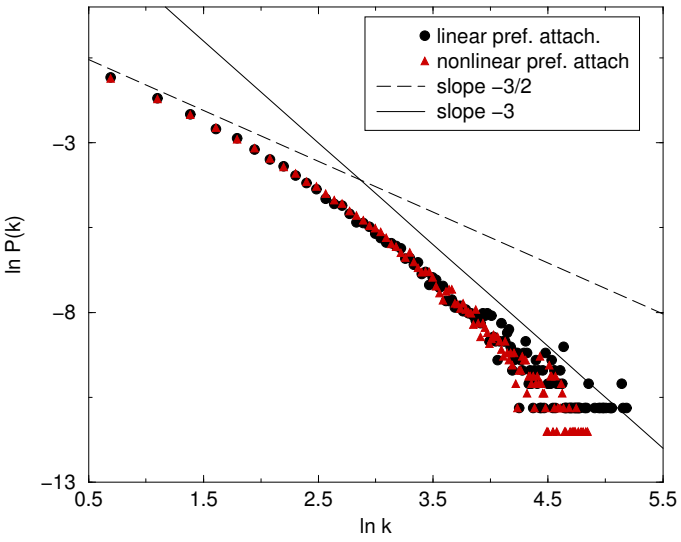
  $\nu = 0$

- $t \to \infty$

  $\Rightarrow P(k) \propto k^{-3/2}$

- Simulation with

  $\nu = 0.75$



- **Nonlinear effects**

Conclusions

- Study focusing on the evolution of the network
- Strong measurement effects
  - average path length: does not saturate, apparently decreases!
- Scaling of the degree distribution
  - crossover in time from $\gamma = 3$ to $\gamma = 1.5$
  - crossover in k from $\gamma = 1.5$ to $\gamma = 3$
  - internal preferential attachment
    - random incoming attachment
    - constant growth
    - linear internal preferential attachment

    $\Longrightarrow$ power-law degree distribution!
- Further suggestions
  - bipartite graph of coauthors and publications
  - nonlinear internal preferential attachment

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