COMPETING LOCAL AND GLOBAL INTERACTIONS IN SOCIAL DYNAMICS: HOW IMPORTANT IS THE FRIENDSHIP NETWORK?

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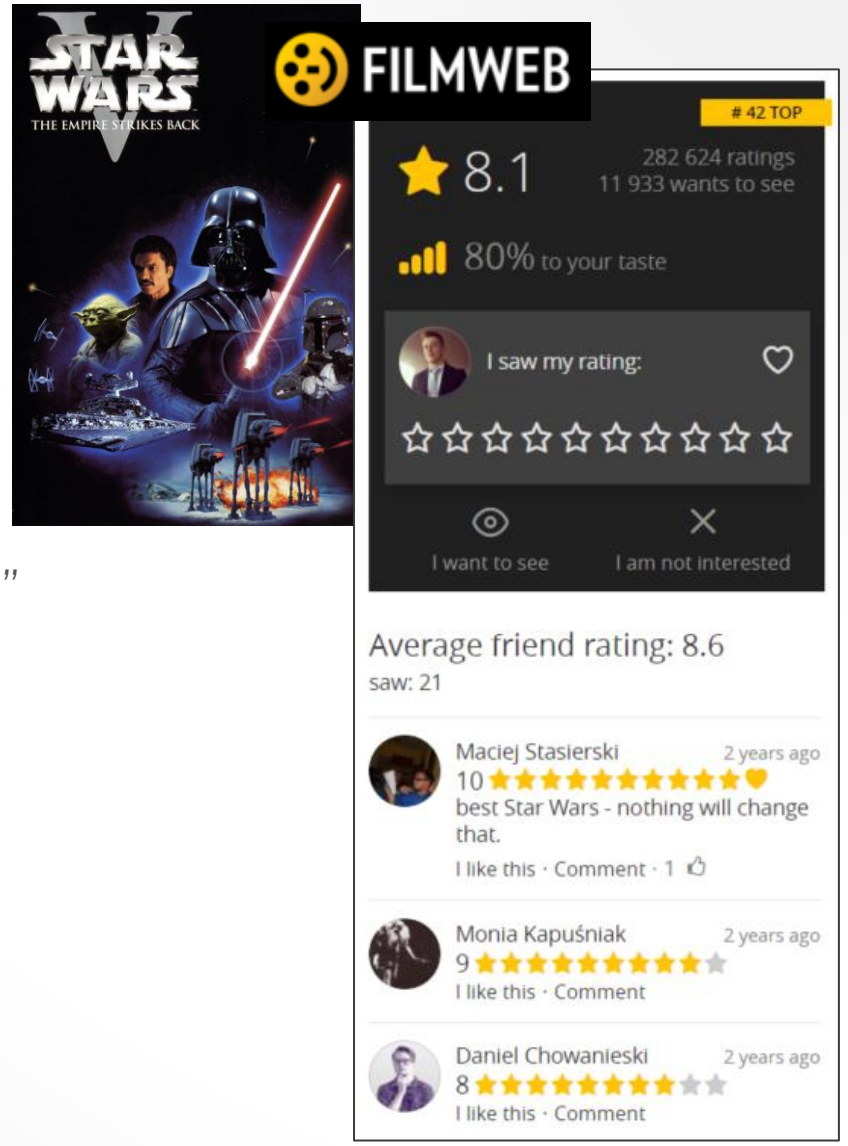
MOTIVATION

- **sources of social influence**
  - local: friends, family
  - global: mass media, online reviews, aggregate measures
- **study on movie ratings**

  „*Do I Follow My Friends or the Crowd? Information Cascades in Online Movie Ratings*"
  Y.-J. Lee, K. Hosanagar, Y. Tan, Manag. Sci. 61(9), 2241 (2015)
- **empirical findings**
  - friends' ratings
    – herding behavior ⇦ conformity
  - strangers' ratings
    – herding or differentiation behavior ⇦ anticonformity



Q-VOTER MODEL

C. Castellano et al., Phys. Rev. E 80, 041129 (2009)
P. Nyczka, K. Sznajd-Weron, and J. Cisło, Phys. Rev. E 86, 011105 (2012)

- **agent-based models**
  - network of interacting N agents
  - source of social influence: q agents
    conformity, anticonformity

R. H. Willis, Sociometry 26(4), 499 (1963)

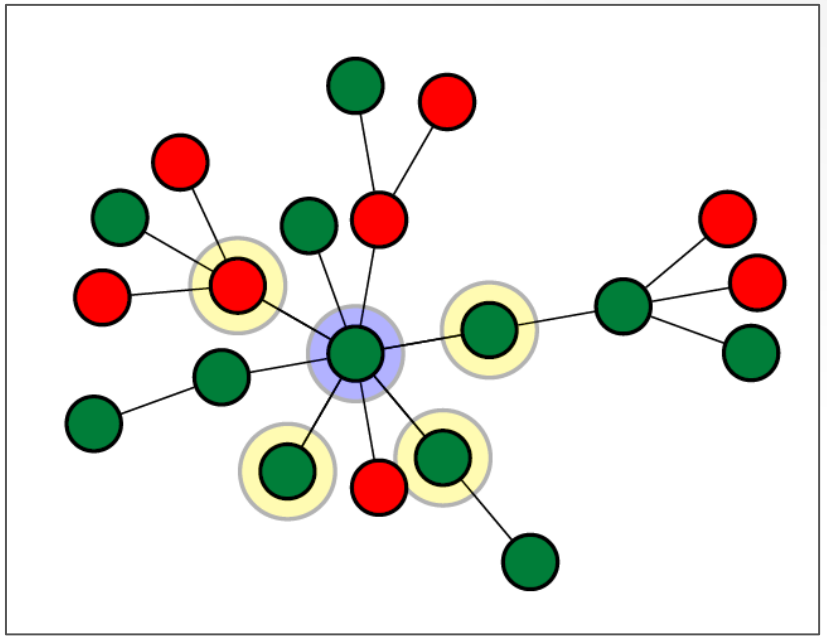
- **binary-state model**
  positive attitude negative attitude

$s_i = 1$

$s_i = -1$

$i = 1,2,\dots,N$

R. W. Robins, R. C. Fraley, and R. F. Krueger,
„*Handbook of research methods in personality psychology*"



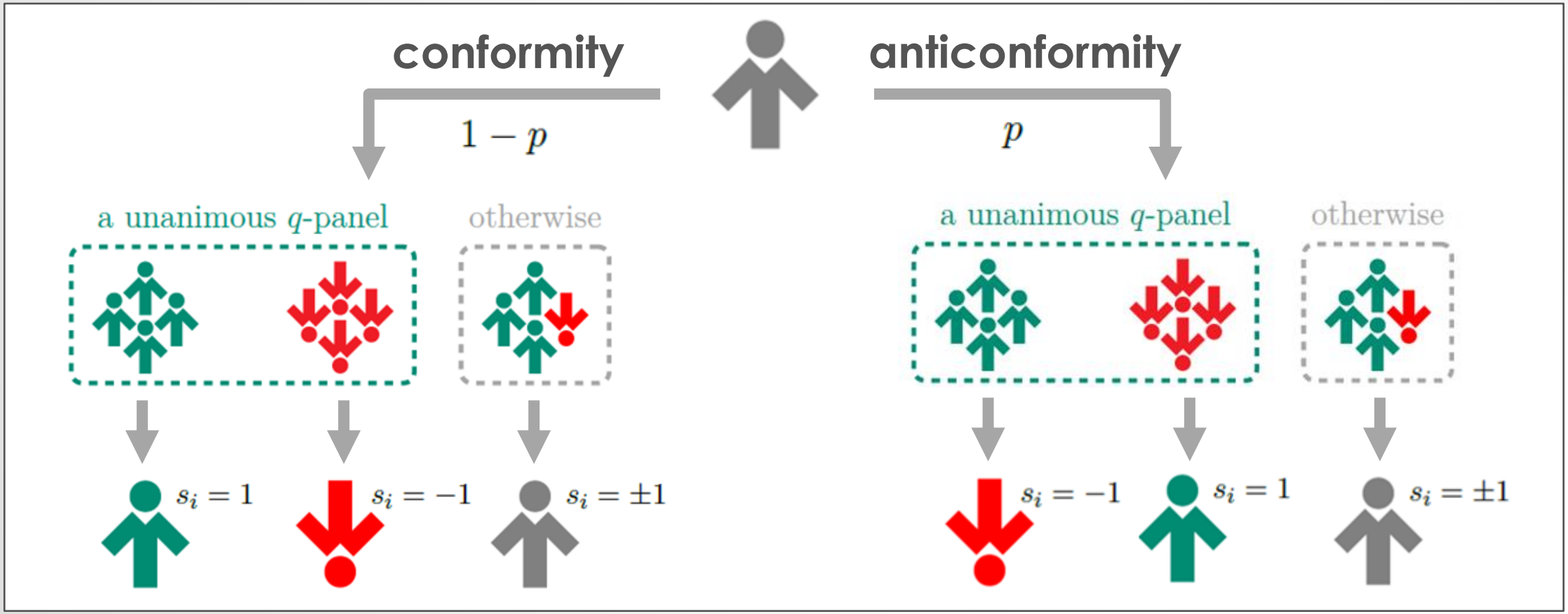
N nodes
1 node =1 agent

Q-VOTER MODEL

two parameters:

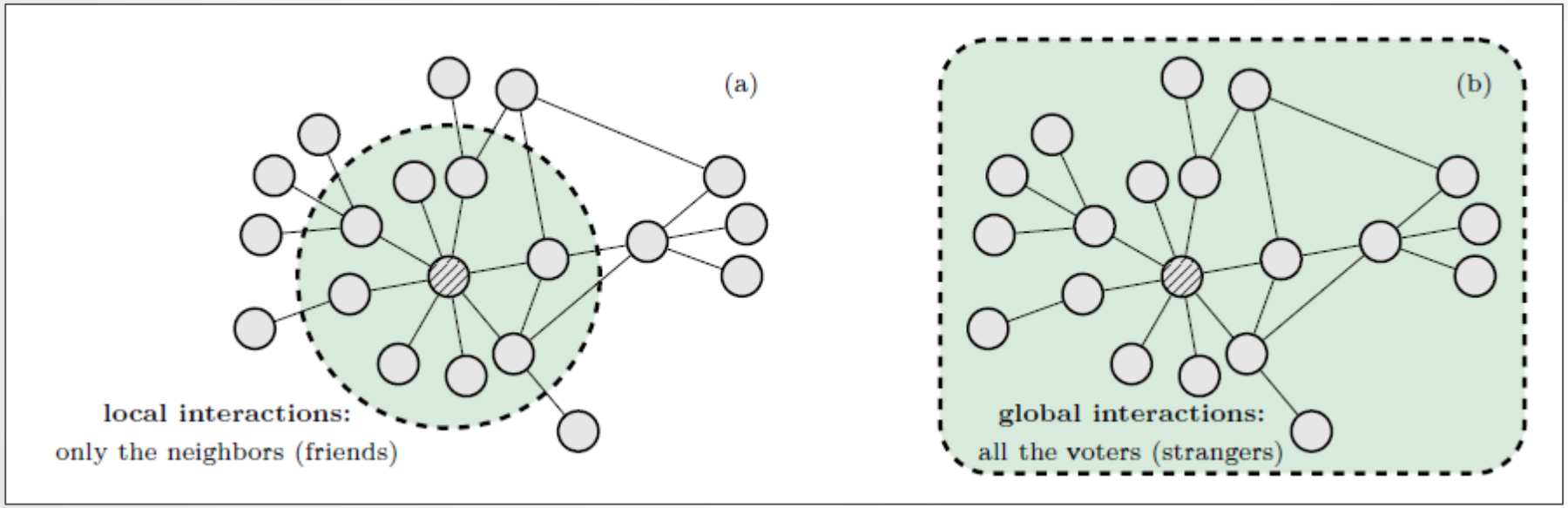
p – probability of anticonformity

q – size of the influence group



P. Nyczka, K. Sznajd-Weron, and J. Cisło, Phys. Rev. E 86, 011105 (2012)

LOCAL AND GLOBAL INTERACTIONS



- **4 different q-voter models:**
  - **GAGC** – global anticonformity and global conformity ⇦ mean-field model
  - **GALC** – global anticonformity and local conformity ⇦ study on movie ratings
  - **LALC** – local anticonformity and local conformity
  - **LAGC** – local anticonformity and global conformity

WHAT DO WE STUDY?

- **quantities of interest**

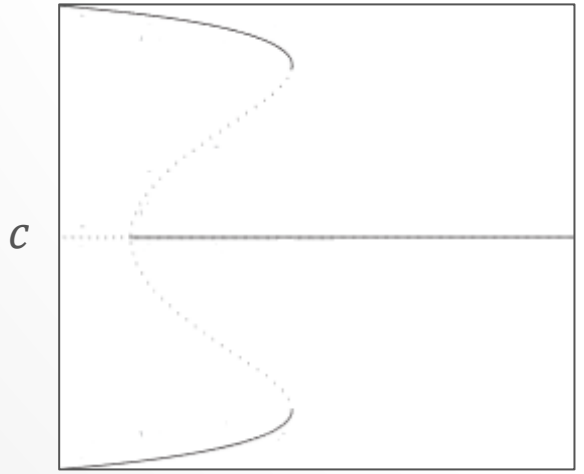
public opinion $m = \frac{1}{N}\sum_{i=1}^{N} s_i$ $\Leftrightarrow$ $c = \frac{1}{2}(1+m)$ concentration of positive agents

- **phase transitions**

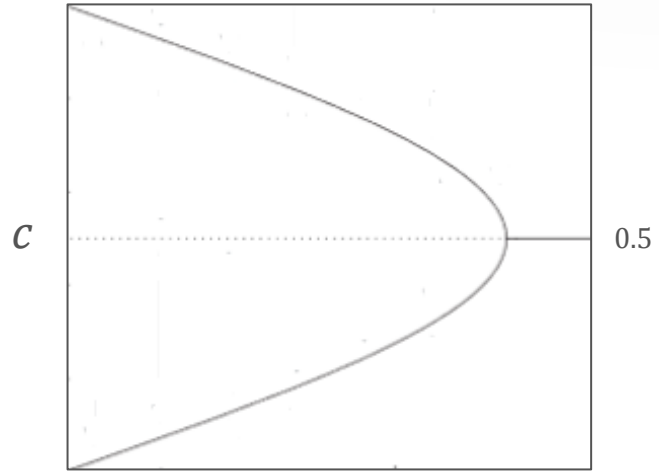
$m = 0$ – disordered phase $(c = 0.5)$

$m \neq 0$ – ordered phase $(c \neq 0.5)$

discontinuous phase transitions



continuous phase transitions



p – probability of anticonformity

ANALYTICAL APPROACH

J. P. Gleeson, Phys. Rev. X 3, 021004 (2013)
A. Jędrzejewski, Phys. Rev. E 95, 012307 (2017)

- **pair approximation**

c – concentration of positive agents

b – concentration of active bonds

$$\begin{cases} \frac{dc}{dt} = \sum_{j\in\{1,-1\}} c_j \sum_k P(k) \sum_{i=0}^{k} \binom{k}{i} \theta_j^i (1-\theta_j)^{k-i} f(j,k,i) \Delta_c \\ \frac{db}{dt} = \sum_{j\in\{1,-1\}} c_j \sum_k P(k) \sum_{i=0}^{k} \binom{k}{i} \theta_j^i (1-\theta_j)^{k-i} f(j,k,i) \Delta_b \end{cases}$$

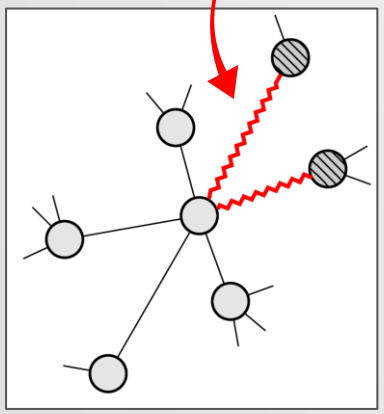
network degree distribution

model dependent

$$\Delta_c = -j \qquad \Delta_b = \frac{2}{\langle k \rangle}(k-2i)$$

j – opinion
k – node degree
i – number of active bonds

$c_1 \equiv c$
$c_{-1} \equiv 1-c$



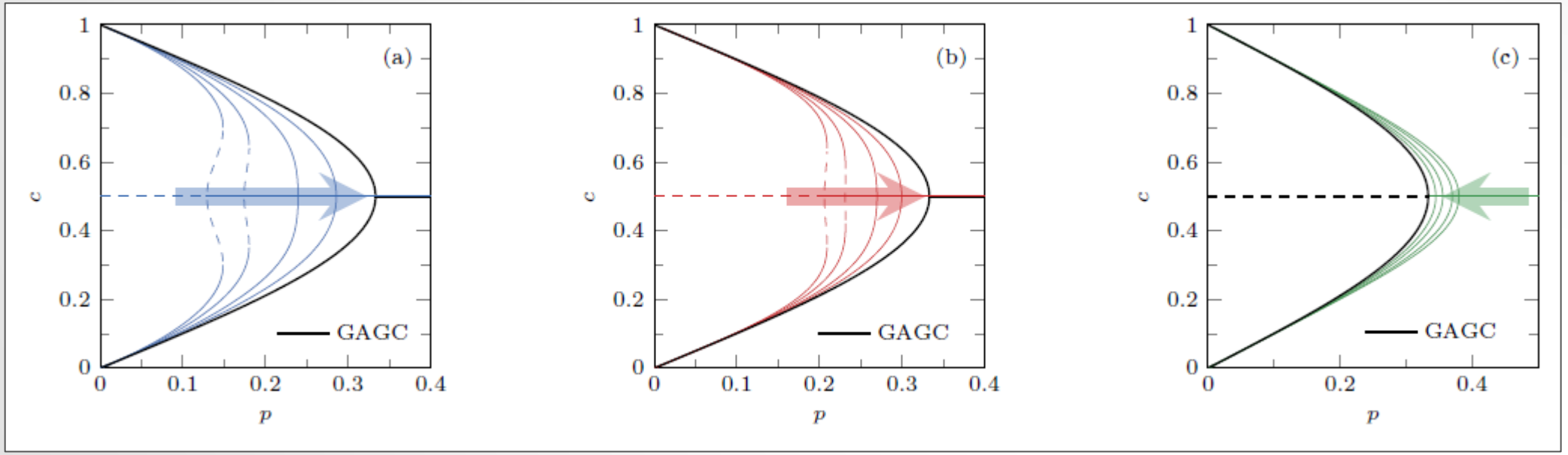
- **assumption:**
  - active bonds binomially distributed $\quad \theta_1 = \frac{b}{2c} \qquad \theta_{-1} = \frac{b}{2(1-c)}$

- **steady states:** $\quad \frac{dc}{dt} = 0 \quad \wedge \quad \frac{db}{dt} = 0$

PHASE DIAGRAMS

⇨ only averege degree matters

GALC model **LALC model** **LAGC model**



$\langle k \rangle$ increase direction, $\langle k \rangle \in \{8, 10, 16, 30\}$, $q = 3$

c – concentration of positive agents
p – probability of anticonformity

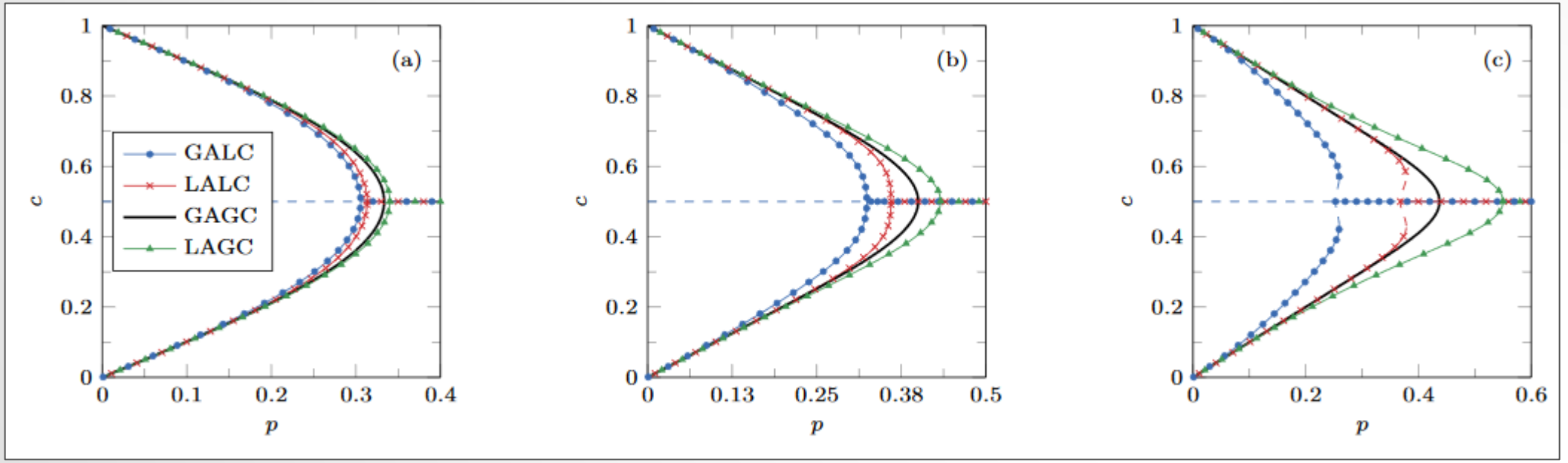
$\langle k \rangle$ – average node degree
q – size of the influence group

MODEL COMPARISON

- **how to choose q?**

„Statistical Physics Of Opinion Formation: Is it a SPOOF?"
A. Jędrzejewski, K. Sznajd-Weron, C. R. Physique 20(4), 244 (2019)

$q = 3$ $q = 5$ $q = 8$



$\langle k \rangle = 50$

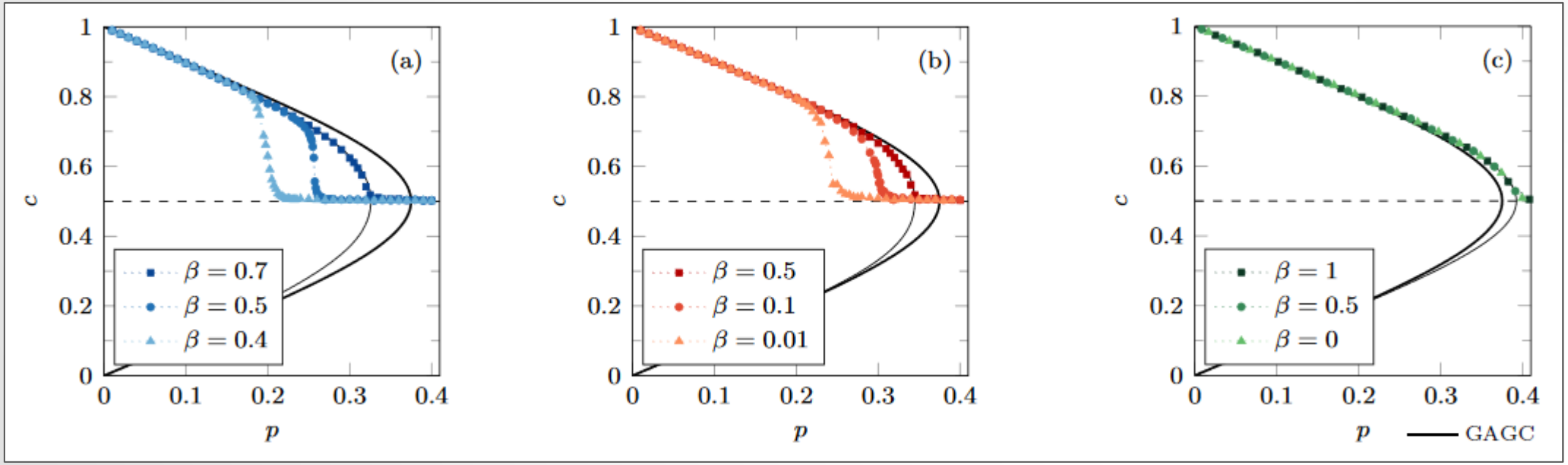
c – concentration of positive agents
p – probability of anticonformity

$\langle k \rangle$ – average node degree
q – size of the influence group

MONTE CARLO SIMULATIONS

- **Watts-Strogatz network model:** β – rewiring probability

GALC model | **LALC model** | **LAGC model**



c – concentration of positive agents
p – probability of anticonformity

$\langle k \rangle$ – average node degree
q – size of the influence group

$q = 4, \langle k \rangle = 50, N = 28160$

CONCLUSIONS

- differentiation between interaction lengths
- global anticonformity and local conformity
  - most sensitive to network structure
  - most difficult to achieve agreement

  } study on movie ratings
- local anticonformity and global conformity
  - low impact of network structure
  - average node degree $\langle k \rangle$ matters

A. Jędrzejewski, B. Nowak, A. Abramiuk, and K. Sznajd-Weron, Chaos 30, 073105 (2020)

THANK YOU!

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