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R-QUEST
Centre for Research Quality and Policy Impact Studies

Mapping Research Fields Using Co-Nomination Analysis: the Case of Heavy Flavour Physics

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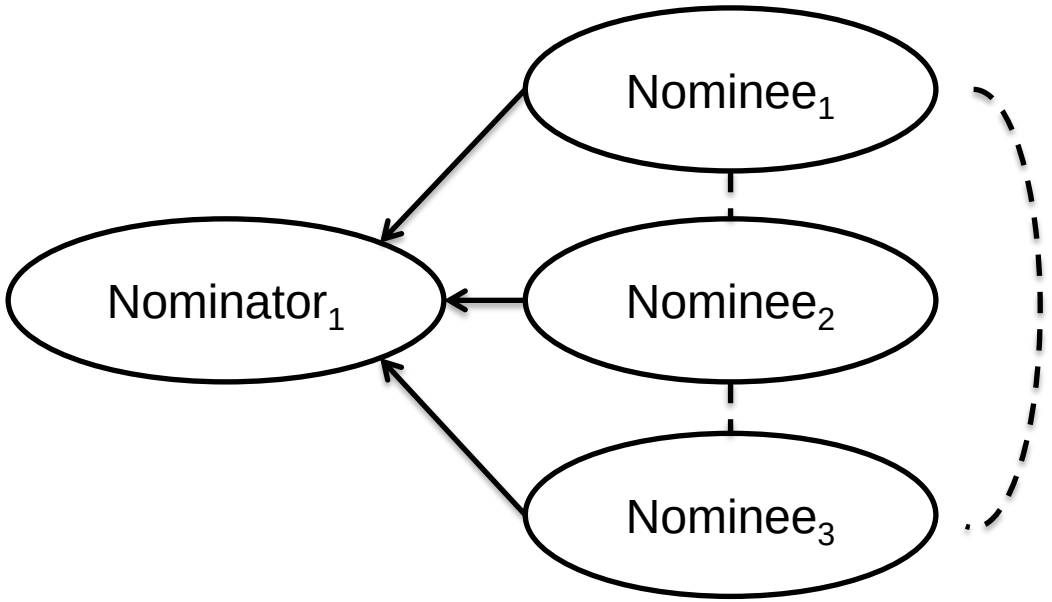
Objective: is Co-Nomination viable?

- We test potential usefulness of co-nomination approach to map **intellectual influence of research fields**
- Conventional citation-based methods of mapping science have '**blind spots'** in mapping intellectual influence:
  - Citing behaviour differs across research fields, within fields, is performative (Rafols et al. 2012)
  - Methodology bias with citation-based techniques affects results (Boyack and Klavans, 2008)
  - Struggle to map intellectual influence, assess its implications in fields with unconventional communication structure (Manganote et al 2016)
- **Research fields** are reputational, organised around **collective intellectual goals** defining material and intellectual rewards (Nedeva 2009; Whitley 2000)

Co-Nomination Approach

- A type of **'snowball' (chain-referral) sampling method**, now mostly used to study 'hard to reach' populations, but also **knowledge** (Fagerberg and Verspagen, 2009), **expert** (Nedeva et al. 1996) and **scientific** communities (Libbey and Zaltman, 1967; Crane, 1972) .
- Strong to map '**core**' and '**elite**' of the network (Borgatti, 2017), which is **representative** of structural relations between members (Wejnert, 2010)



SOLID line – Assumed intellectual influence

DASHED line – Assumed intellectual proximity

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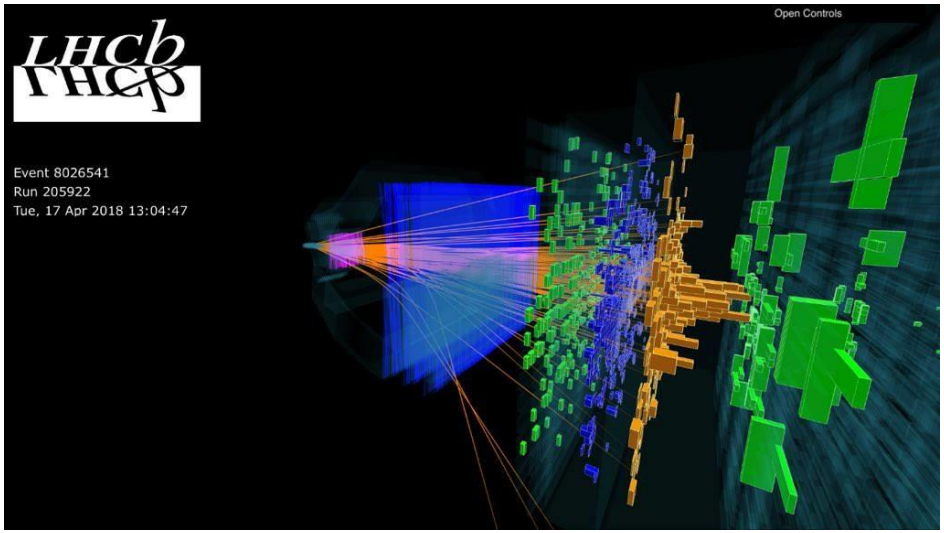
Research Field: Heavy Flavour Physics (HFP)

- Part of high energy particle physics (HEP) - seeking new particles, measuring particle interactions to discover physics beyond the Standard Model
- Distinguished from other HEP by **intellectual specialisation**: “Hadron containing charm (c) or beauty (b) quarks or antiquarks are known as heavy flavoured particles” (Gershon & Needham 2017)
- **Organised around bodies of knowledge** rather than associations, institutions or publication outlets
- Reliant upon **large-scale, complex, globally-unique facilities** (e.g. CERN), continuous long-term funding from national bodies
- Divided into **theoretical and experimental branches** with distinct publication, citation patterns (Lehmann et al., 2003)
- Main experimental group: **LHCb at CERN**



Credit: LHCb Social Media

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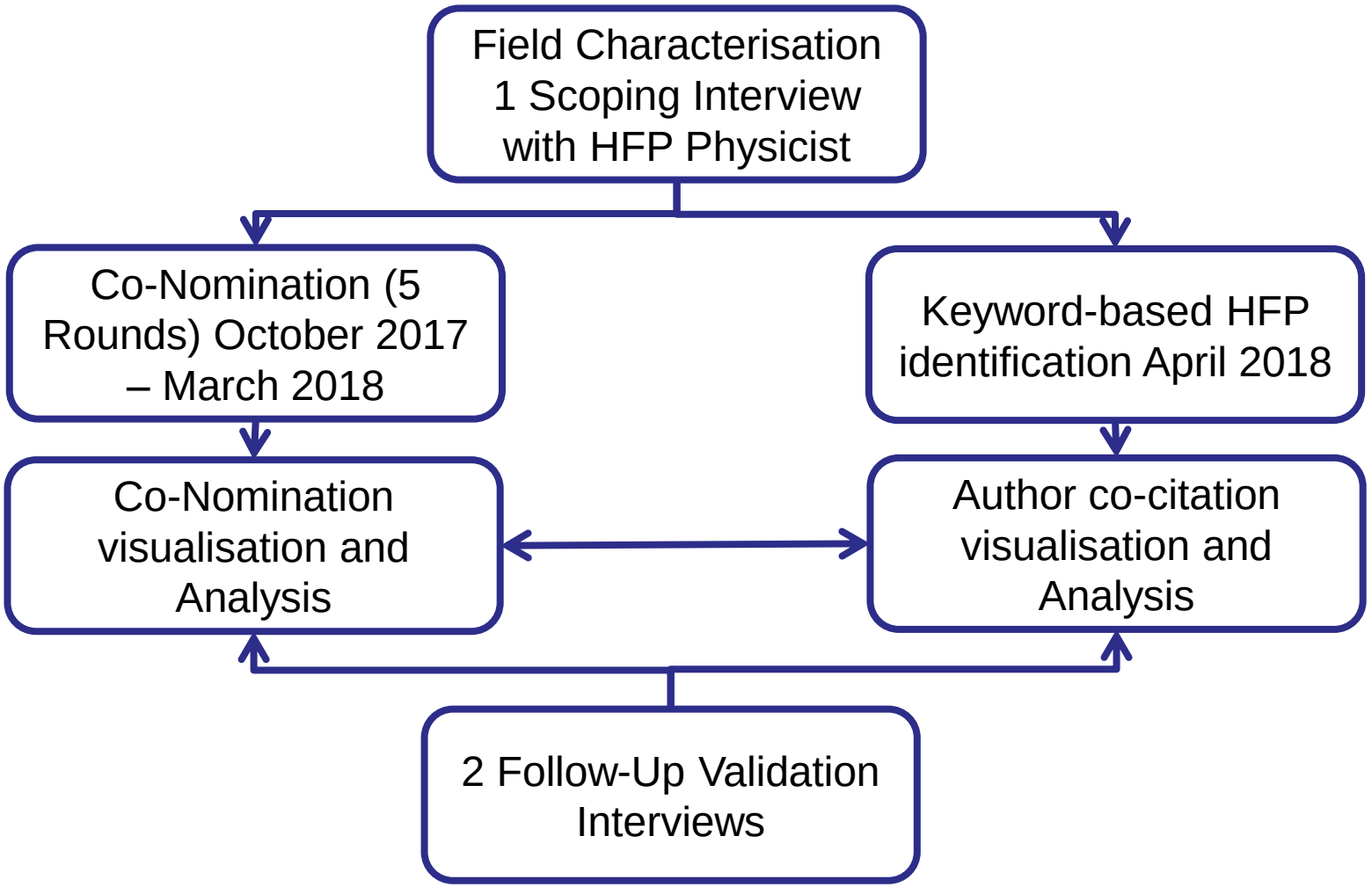
Empirical Problem with Bibliometric Mapping of Experimental HFP

Test of lepton flavor universality by the measurement of the B-0 -> D*(-) tau(+) nu(tau) branching fraction using three-prong tau decays

By: Aaij, R (Aaij, R.)[40]; Adeva, B (Adeva, B.)[39]; Adinolfi, M (Adinolfi, M.)[48]; Ajaltouni, Z (Ajaltouni, Z.)[5]; Akar, S (Akar, S.)[59]; Albrecht, J (Albrecht, J.)[10]; Alessio, F (Alessio, F.)[40]; Alexander, M (Alexander, M.)[53]; Albero, AA (Alfonso Albero, A.)[38,57,92]; Ali, S (Ali, S.)[43]; Alkhazov, G (Alkhazov, G.)[31]; Cartelle, PA (Cartelle, P. Alvarez)[55]; Alves, AA (Alves, A. A., Jr.)[59]; Amato, S (Amato, S.)[2]; Amerio, S (Amerio, S.)[23]; Amhis, Y (Amhis, Y.)[7]; An, L (An, L.)[3]; Anderlini, L (Anderlini, L.)[15]; Andreassi, G (Andreassi, G.)[41]; Andreotti, M (Andreotti, M.)[17,82]; Andrews, JE (Andrews, J. E.)[60]; Appleby, RB (Appleby, R. B.)[56]; Archilli, F (Archilli, F.)[43]; d'Argent, P (d'Argent, P.)[12]; Romeu, JA (Romeu, J. Arnau)[6]; Artamonov, A (Artamonov, A.)[37]; Artuso, M (Artuso, M.)[61]; Aslanides, E (Aslanides, E.)[6]; Auriemma, G (Auriemma, G.)[26]; Baalouch, M (Baalouch, M.)[5]; Babuschkin, I (Babuschkin, I.)[56]; Bachmann, S (Bachmann, S.)[12]; Back, JJ (Back, J. J.)[50]; Badalov, A (Badalov, A.)[38,88]; Baesso, C (Baesso, C.)[62,63]; Baker, S (Baker, S.)[55]; Balagura, V (Balagura, V.)[7,77]; Baldini, W (Baldini, W.)[17]; Baranov, A (Baranov, A.)[35]; Barlow, RJ (Barlow, R. J.)[56]; Barschel, C (Barschel, C.)[40]; Barsuk, S (Barsuk, S.)[7]; Barter, W (Barter, W.)[56]; Baryshnikov, F (Baryshnikov, F.)[32]; Batozskaya, V (Batozskaya, V.)[29]; Battista, V (Battista, V.)[41]; Bay, A (Bay, A.)[41]; Beaucourt, L (Beaucourt, L.)[4]; Beddow, J (Beddow, J.)[53]; Bedeschi, F (Bedeschi, F.)[24]; Bediaga, I (Bediaga, I.)[1]; Beiter, A (Beiter, A.)[61]; Bel, LJ (Bel, L. J.)[43]; Beliy, N (Beliy, N.)[64,65]; Bellee, V (Bellee, V.)[41]; Belloli, N (Belloli, N.)[21,84]; Belous, K (Belous, K.)[37]; Belyaev, I (Belyaev, I.)[32]; Ben-Haim, E (Ben-Haim, E.)[8]; Bencivenni, G (Bencivenni, G.)[19]; Benson, S (Benson, S.)[43]; Beranek, S (Beranek, S.)[9]; Berezhnoy, A (Berezhnoy, A.)[33]; Bernet, R (Bernet, R.)[42]; Berninghoff, D (Berninghoff, D.)[12]; Bertholet, E (Bertholet, E.)[8]; Bertolin, A (Bertolin, A.)[23]; Betancourt, C (Betancourt, C.)[42]; Betti, F (Betti, F.)[15]; Bettler, MO (Bettler, M. -O.)[40]; van Beuzekom, M (van Beuzekom, M.)[43]; Bezshyiko, I (Bezshyiko, Ia.)[42]; Bifani, S (Bifani, S.)[47]; Billoir, P (Billoir, P.)[8]; Birnkraut, A (Birnkraut, A.)[10]; Bitadze, A (Bitadze, A.)[56]; Bizzeti, A (Bizzeti, A.)[18,96]; Bjorn, M (Bjorn, M.)[57]; Blake, T (Blake, T.)[50]; Blanc, F (Blanc, F.)[41]; Blouw, J (Blouw, J.)[11]; Blusk, S (Blusk, S.)[61]; Bocci, V (Bocci, V.)[26]; Boettcher, T (Boettcher, T.)[58]; Bondar, A (Bondar, A.)[36,98]; Bondar, N (Bondar, N.)[31]; Bonivento, W (Bonivento, W.)[16]; Bordyuzhin, I (Bordyuzhin, I.)[32]; Borgheresi, A (Borgheresi, A.)[21,84]; Borghi, S (Borghi, S.)[56]; Borisyak, M (Borisyak, M.)[35]; Borsato, M (Borsato, M.)[39]; Bossu, F (Bossu, F.)[7]; Boubdir, M (Boubdir, M.)[9]; Bowcock, TJV (Bowcock, T. J. V.)[54]; Bowen, E (Bowen, E.)[42]; Bozzi, C (Bozzi, C.)[17,40]; Braun, S (Braun, S.)[12]; Britton, T (Britton, T.)[61]; Brodzicka, J (Brodzicka, J.)[27]; Brundu, D (Brundu, D.)[16]; Buchanan, E (Buchanan, E.)[48]; Burr, C (Burr, C.)[56]; Bursche, A (Bursche, A.)[16,81]; Buytaert, J (Buytaert, J.)[40]; Byczynski, W (Byczynski, W.)[40]; Cadeddu, S (Cadeddu, S.)[16]; Cai, H (Cai, H.)[65,66]; Calabrese, R (Calabrese, R.)[17,82]; Calladine, R (Calladine, R.)[47]; Calvi, M (Calvi, M.)[21,84]; Gomez, MC (Calvo Gomez, M.)[38,88]; Camboni, A (Camboni, A.)[38,88]; Campana, P (Campana, P.)[19]; Perez, DHC (Campora Perez, D. H.)[40]; Capriotti, L (Capriotti, L.)[56]; Carbone, A (Carbone, A.)[15,80]; Carboni, G (Carboni, G.)[25,85]; Cardinale, R (Cardinale, R.)[20,83]; Cardini, A (Cardini, A.)[16]; Carniti, P (Carniti, P.)[21,84]; Carson, L (Carson, L.)[52]; Akiba, KC (Carvalho Akiba, K.)[2]; Casse, G (Casse,

Research Design



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Mapping heavy Flavour Physics – Author Co-Citation

- Keyword-based search of publications in Web of Science (2013-2018, search date 06 April 2018)
- Goal: maximise precision at expense of recall, capture core contributions in the field
- 2,439 results
- First author co-citation: authors cited more than 10 times; co-citation of 2 authors in same publication assumes intellectual link between them
- 1974 cited authors (nodes) and 386,136 links between them (edges)

Query:

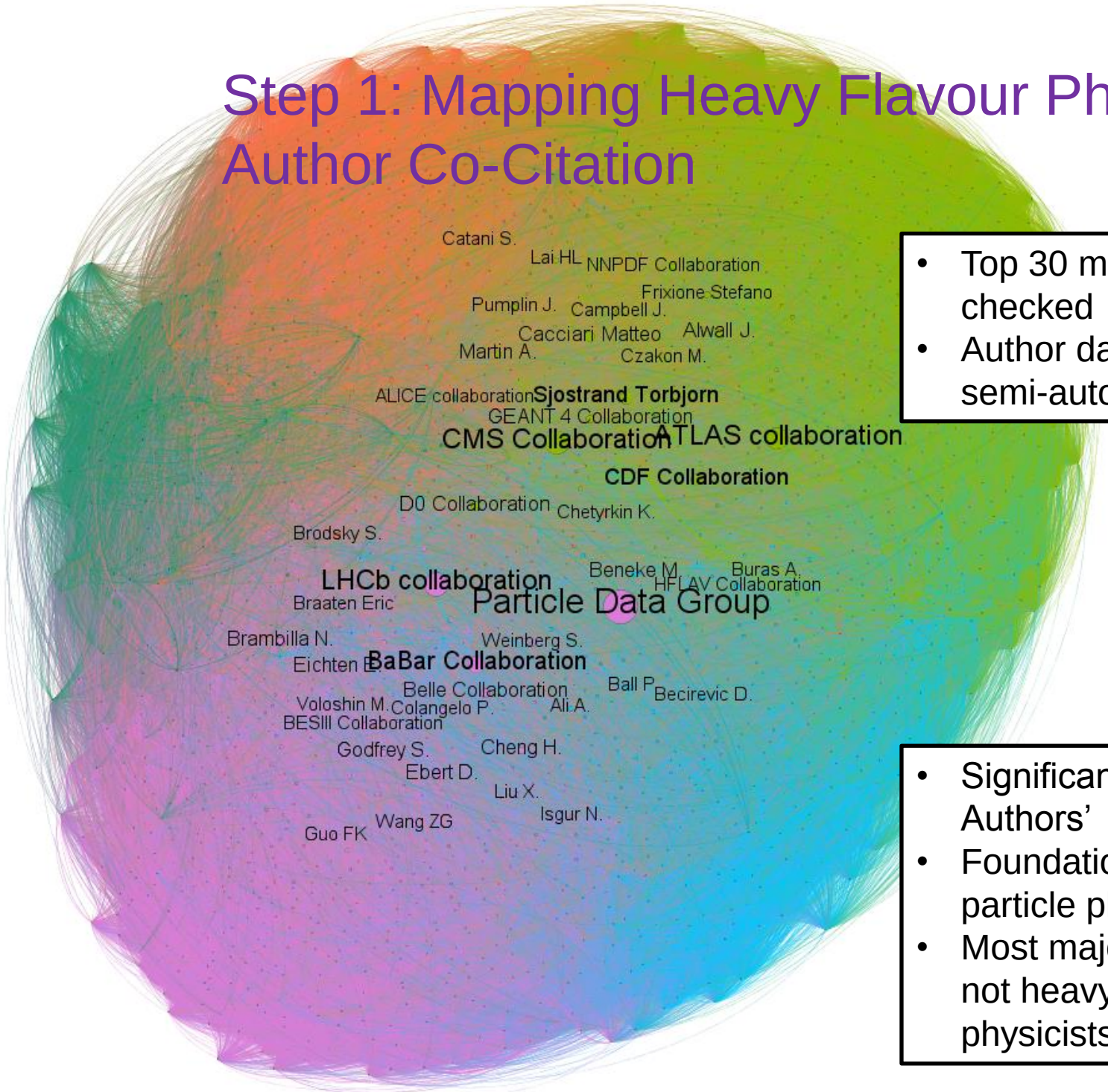
TS=(((Charm* OR bottom* OR beauty*) AND (quark OR meson* OR mixing OR "rare decays")) OR ("b quark*" OR "c quark*" OR "b meson*" OR "c meson*") OR ("b-quark*" OR "c-quark*") OR ("heavy flavour" OR "heavy flavor"))

AND **WC**=(Physics, Particles & Fields)

AND **LANGUAGE:** (English)

AND **DOCUMENT TYPES:** (Article)

Step 1: Mapping Heavy Flavour Physics – Author Co-Citation

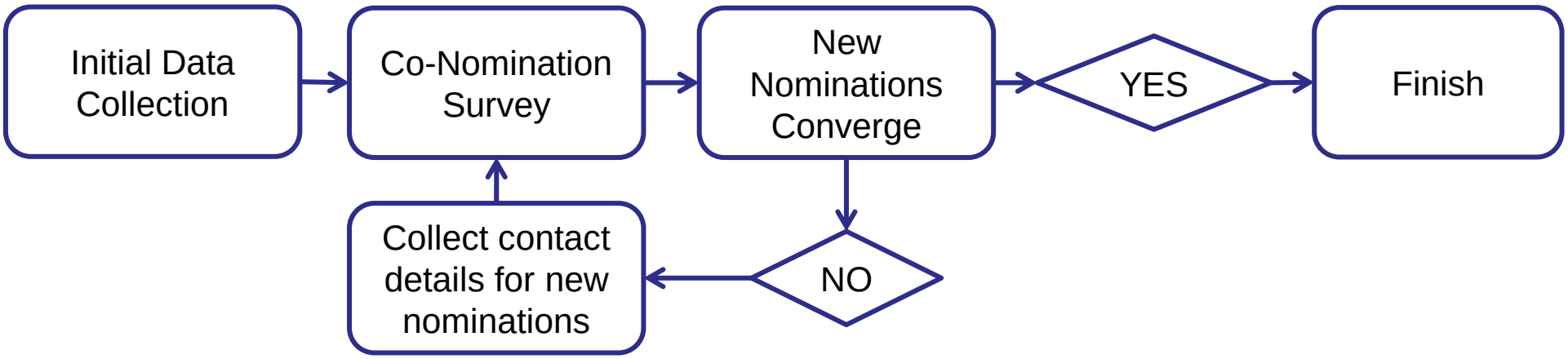


- Top 30 manually checked
- Author data cleaned semi-automatically

- Significant role of ‘Group Authors’
- Foundational authors of particle physics
- Most major nodes are not heavy flavour physicists

Co-Nomination Process - Survey

- Co-Nomination question**: Can you please name up to five people that influence you the most intellectually at the moment?**
- Measures **current**, **direct** intellectual influence
- Initial name set composed from 3 regular HFP workshops
- Data collection iterative; finishes when few new nominations



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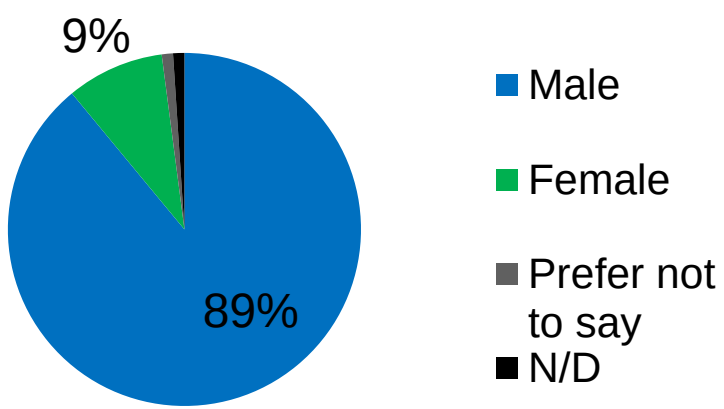
HFP Co-Nomination Data Collection Results

5 survey rounds; 291 responses total; 671 unique nominations (1691 pairs)

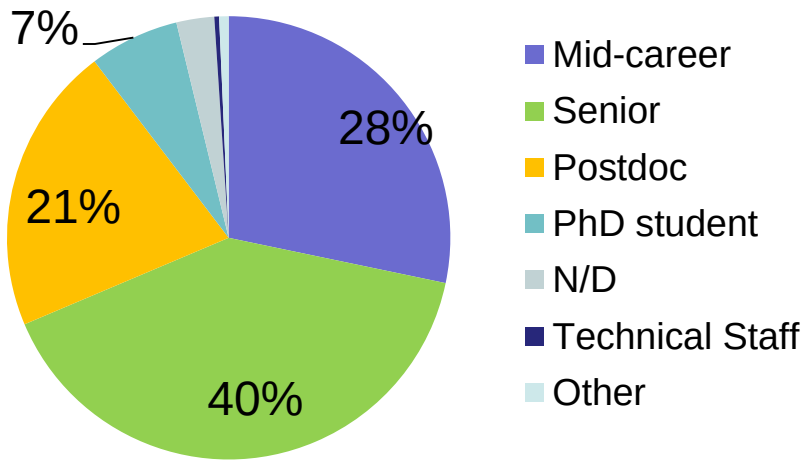
- 20% average response rate
- Mostly from HFP (self opt-in)
- Median experience in field: 15 years
- Median academic age: 14.5 years
- 75% new nominations (R1) ➔ 30% (R5)

	R1	R2	R3	R4	R5
Responses	86	93	71	32	9
RR	17.7%	28.3%	22.3%	12.5%	10%

Gender Profile



Career Type and Stage



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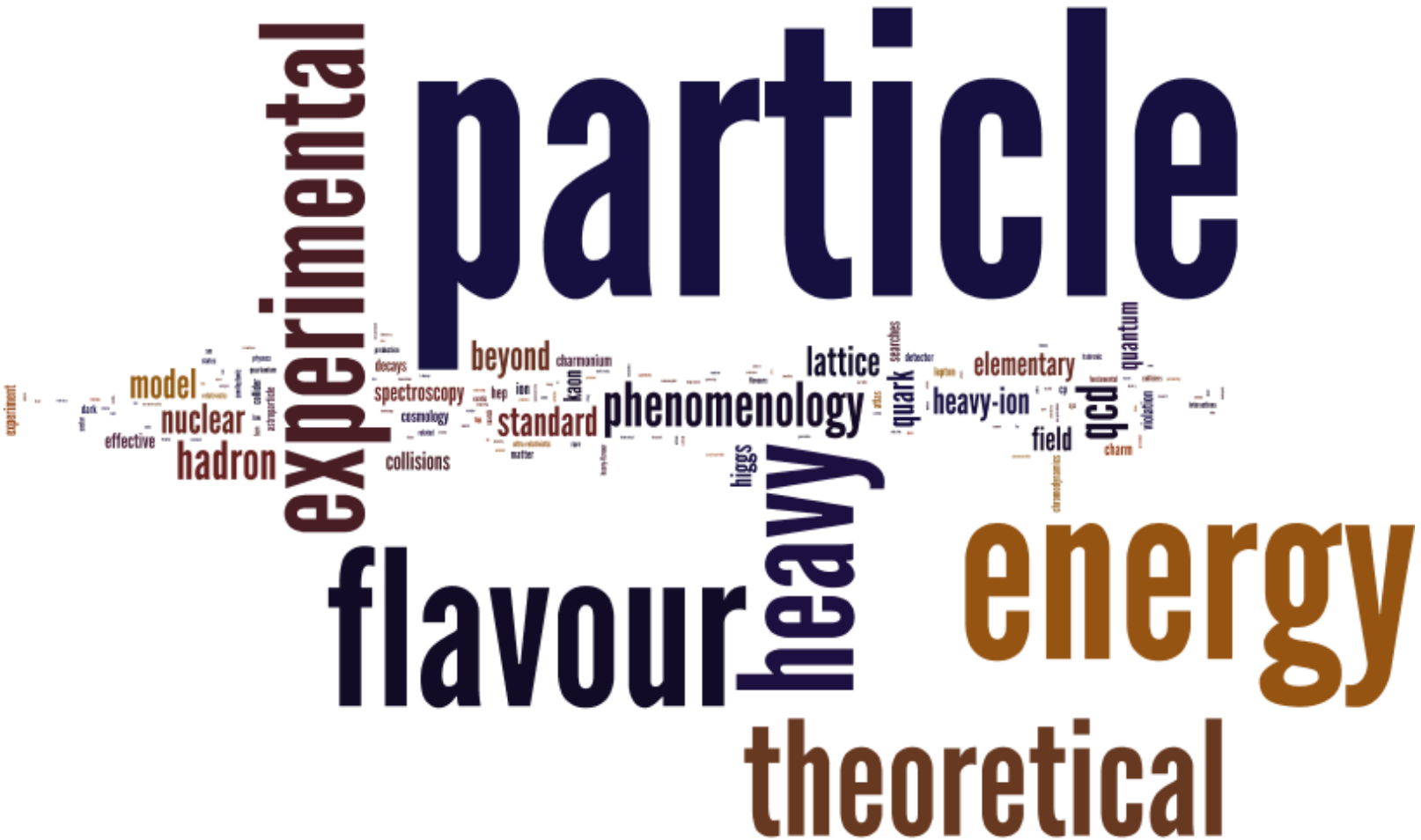
HFP Co-Nomination Data – Respondents' Research Topics



Graphic produced using Wordle.com

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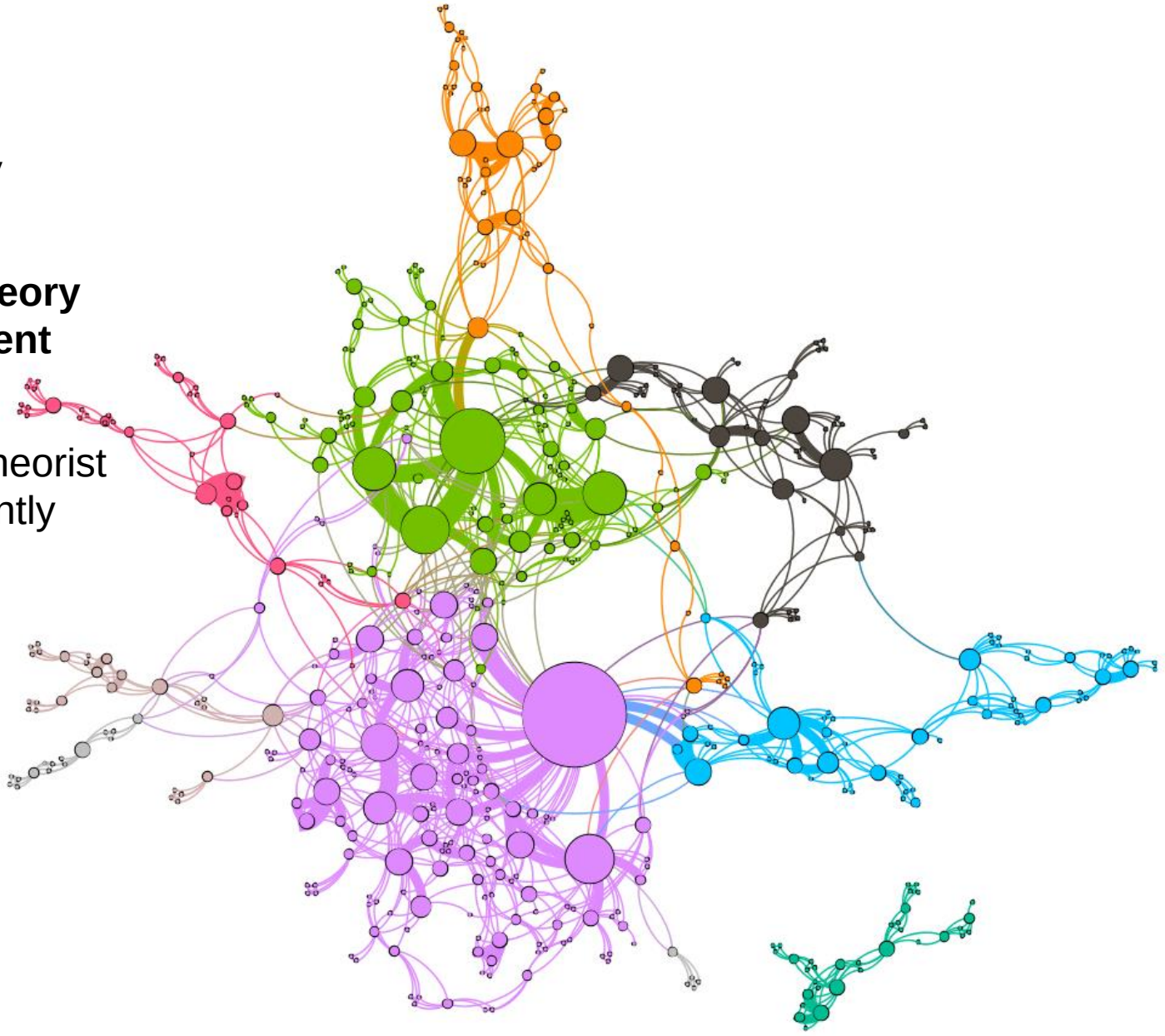
Structure of Intellectual Influence in HFP

- Most **nodes** are heavy flavour physicists
- Distinction between **theory** (bottom) and **experiment** (top)
- Largest node (**pink**): theorist whose ideas are currently 'exciting'
- 10 clusters represent **theory**, **experiment**, **equipment** divides



Co-Nomination is viable.

- **It shows the core structure of the field**; major intellectually influential figures
- **Intellectual relationships** and **clusters** in HFP (including stable collaborations) are mapped mostly **accurately**; the scale of intellectual influence is subject to response bias
- It disambiguates experimental branch of HFP, shows **intellectually influential** figures
  - Somewhat coincides with organisational roles: **coordinators**, **spokespeople**
- It reflects intellectual structure, emphasises current '**trendy**', '**exciting**' topics
  - Mostly **HFP field** members; some minor clusters from related fields

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Using Co-Nomination for mapping research fields: pros and cons

Pros

- **Contemporary**, real time field structure
- Disambiguates individual-level reputation, perceived by research field members, **not as mediated** by citing behaviour
- **Meaningful results**, validated by field specialists
- Goes where citation-based methods cannot…
  - Can map fields that do not rely on WoS-indexed publications in scholarly communication
  - Can map 'epistemic communities' where knowledge is co-produced (potentially also with non-academic scientists, e.g. industry researchers)

Using Co-Nomination for mapping research fields: pros and cons

Cons

- **Response bias**: only the core structure is accurate; some groups perceived as significant to the field are not represented strongly enough
- Does not show '**intellectual foundations**' (eminent figures)
- Influence of short-lived fads and **fashions**
- **Obtrusive**, **expensive** to implement

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Thank You!

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Next Steps

- Repeat mapping exercise (with matching research design) in **two more** physics fields:
  - Quantum many-body physics of ultracold atoms
  - (Supersymmetry) String theory
- Compare results
- Analyse potential sources of bias of co-nomination method to address them
- Analyse strengths and weaknesses of method