

arXiv

Sustainability Initiative Update

Cornell University Library
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Cornell University
Library

arXiv.org

Universal properties in galaxies and cored DM profiles

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1 Abstract

In this paper I report the highlights of the talk: "Universal properties in galaxies and cored DM profiles", given at: Colloquium Lectures, Ecole Internationale d'Astrophysique Daniel Chalonge. The 14th Paris Cosmology Colloquium 2010 "The Standard Model of the Universe: Theory and Observations".

2 Highlights

The presence of large amounts of unseen matter in galaxies, distributed differently from stars and gas, is well established from rotation curves (RCs) which do not show the expected Keplerian fall-off at large radii (Rubin et al. 1980), but increase, remain flat or start to gently decrease according to a well organized pattern that involves an invisible mass component becoming progressively more abundant at outer radii and in the less luminous galaxies (Perse, Salucci & Stel 1996).

In Spirals we have the best opportunity to study the mass distribution: the gravitational potentials of a spherical stellar bulge, a dark halo, a stellar disk and a gaseous disk give rise to an observed equilibrium circular velocity

$$V_{\text{tot}}^2(r) = r \frac{d}{dr} \phi_{\text{tot}} = V_b^2 + V_{DM}^2 + V_*^2 + V_{HI}^2.$$

The Poisson equation relates the surface (spatial) densities of these components to the corresponding gravitational potentials. The investigation is not difficult: e.g. $\Sigma_*(r)$, the surface stellar density, is pro-

portional (by the mass-to-light ratio) to the observed surface brightness:

$$\Sigma_*(r) = \frac{M_D}{2\pi R_D^2} e^{-r/R_D}$$

and then

$$V_*^2(r) = \frac{GM_D}{2R_D} x^2 B\left(\frac{x}{2}\right),$$

where M_D is the disk mass, R_D the disk length-scale and $B(x)$ a combination of Bessel functions.

Dark and luminous matter in spirals are coupled: at any galactocentric radii R_n measured in terms of disk length-scale $R_n = (n/5) R_{\text{opt}}$ ($R_{\text{opt}} = 3.2R_D$), there is a *Radial Tully-Fisher relation* (Yegorova & Salucci 2007), i.e. a relation between the local rotation velocity $V(R_n)$ and the total galaxy luminosity: $M_{\text{band}} = a_n \log V_n + b_n$. Spirals present universal features in their kinematics that correlate with their global galactic properties (PSS and Salucci et al. 2007).

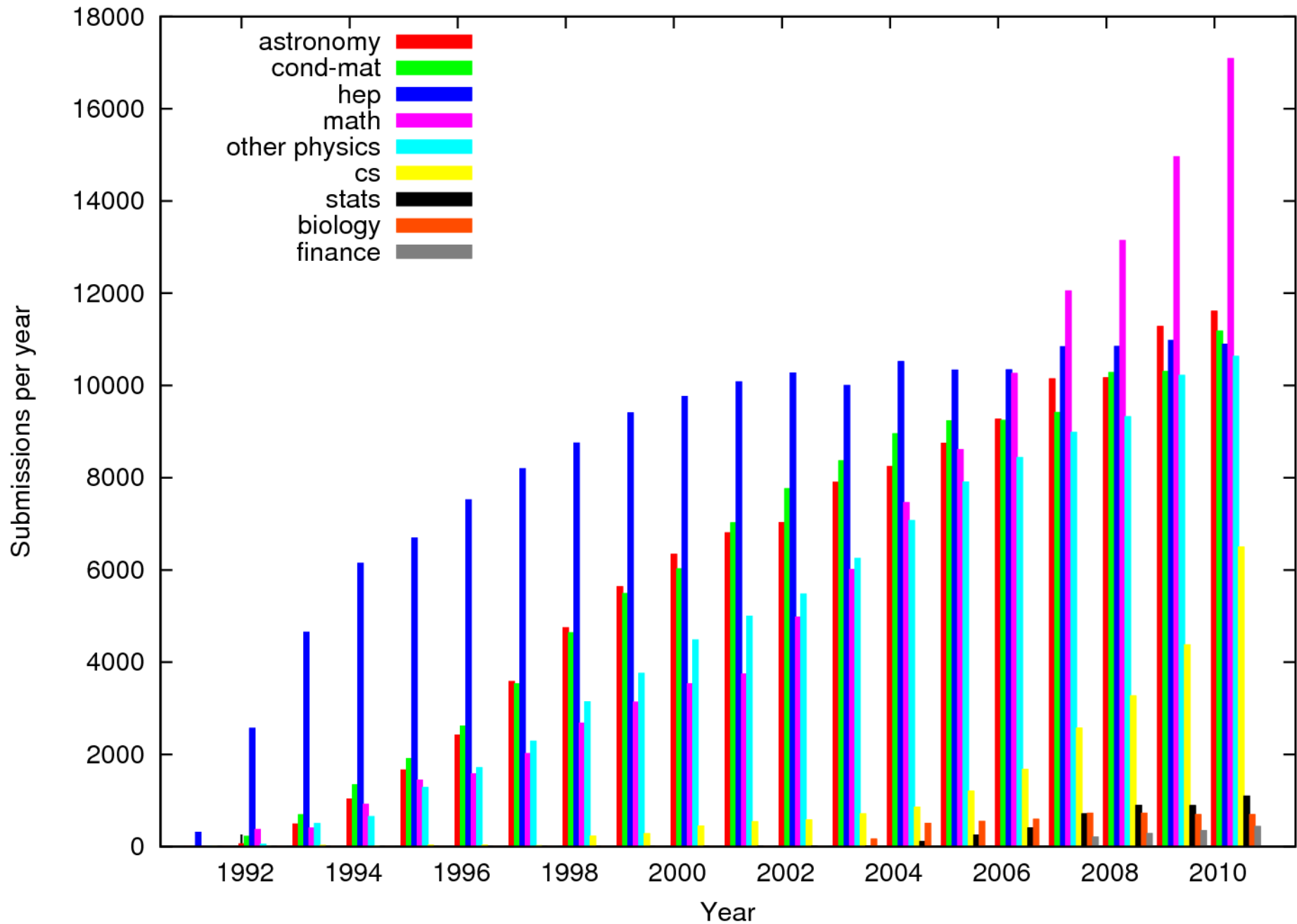
This led to the discovery, from 3200 individual RCs, of the "Universal Rotation Curve" of Spirals $V_{URC}(r, L)$ (see PSS and Fig. 1), i.e. a function of galactocentric radius r , that, tuned by a global galaxy property (e.g. the luminosity), well reproduces, out to the virial radius (Shankar et al. 2006), the RC of any spiral (Salucci et al. 2007). V_{URC} is the observational counterpart to which the circular velocity profile emerging in cosmological simulations must comply (link to www.youtube.com/user/dvd5film#p/u/1/YegadVb-WJI for a 3-D visualization of the URC).

In the same way of individual RCs, it underlies a mass model that includes a Freeman disk and a DM

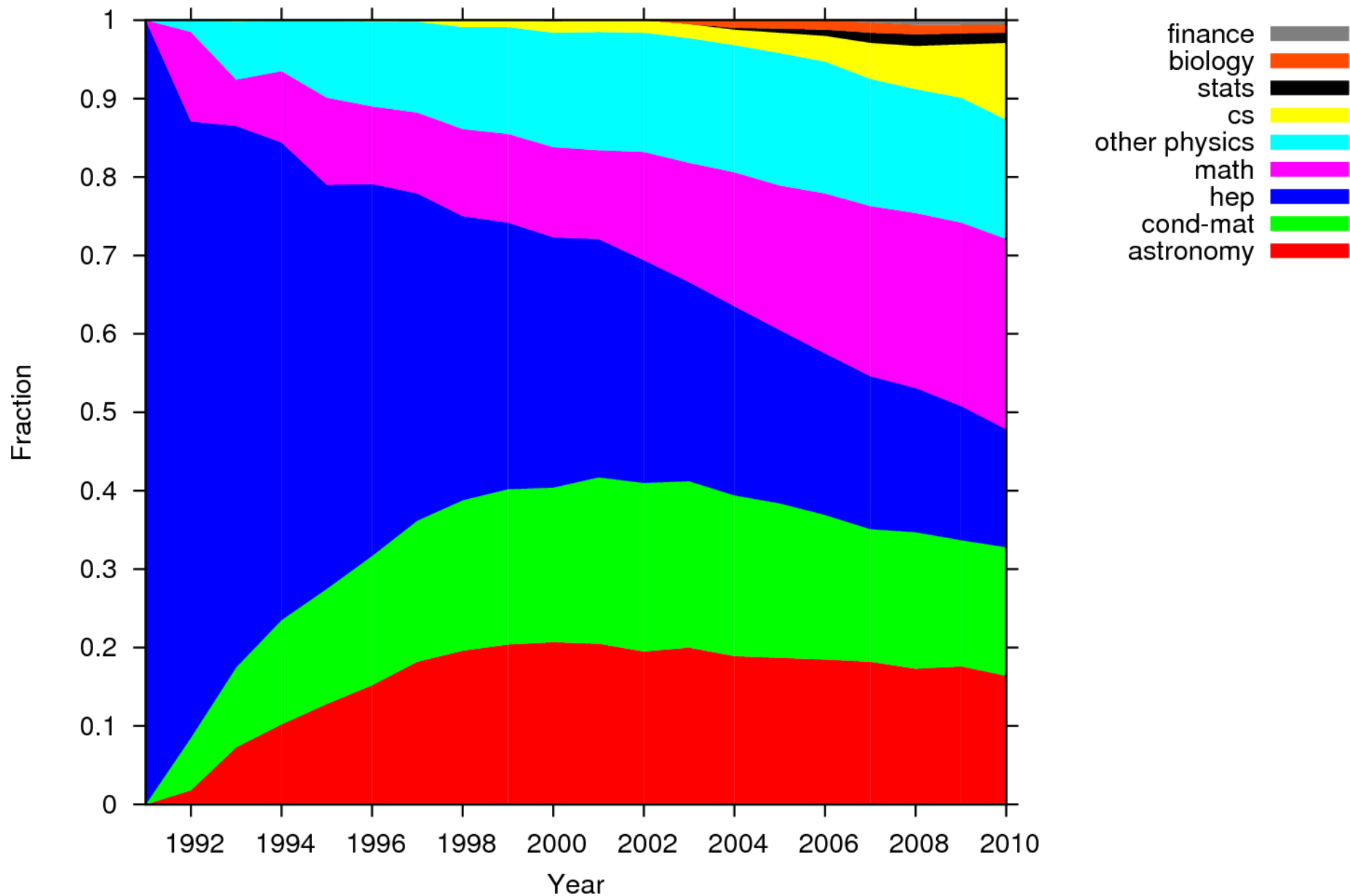
- established in 1991 by Paul Ginsparg
- has been hosted at Cornell since 2001
- includes 702,000 e-prints
- usage data from 2010:
 - 70,138 new submissions
 - 40 million downloads
- unit costs for 2010 (continues to go down!)
 - \$4.70 per submission
 - 0.08 cents per download

Principles and Value Proposition

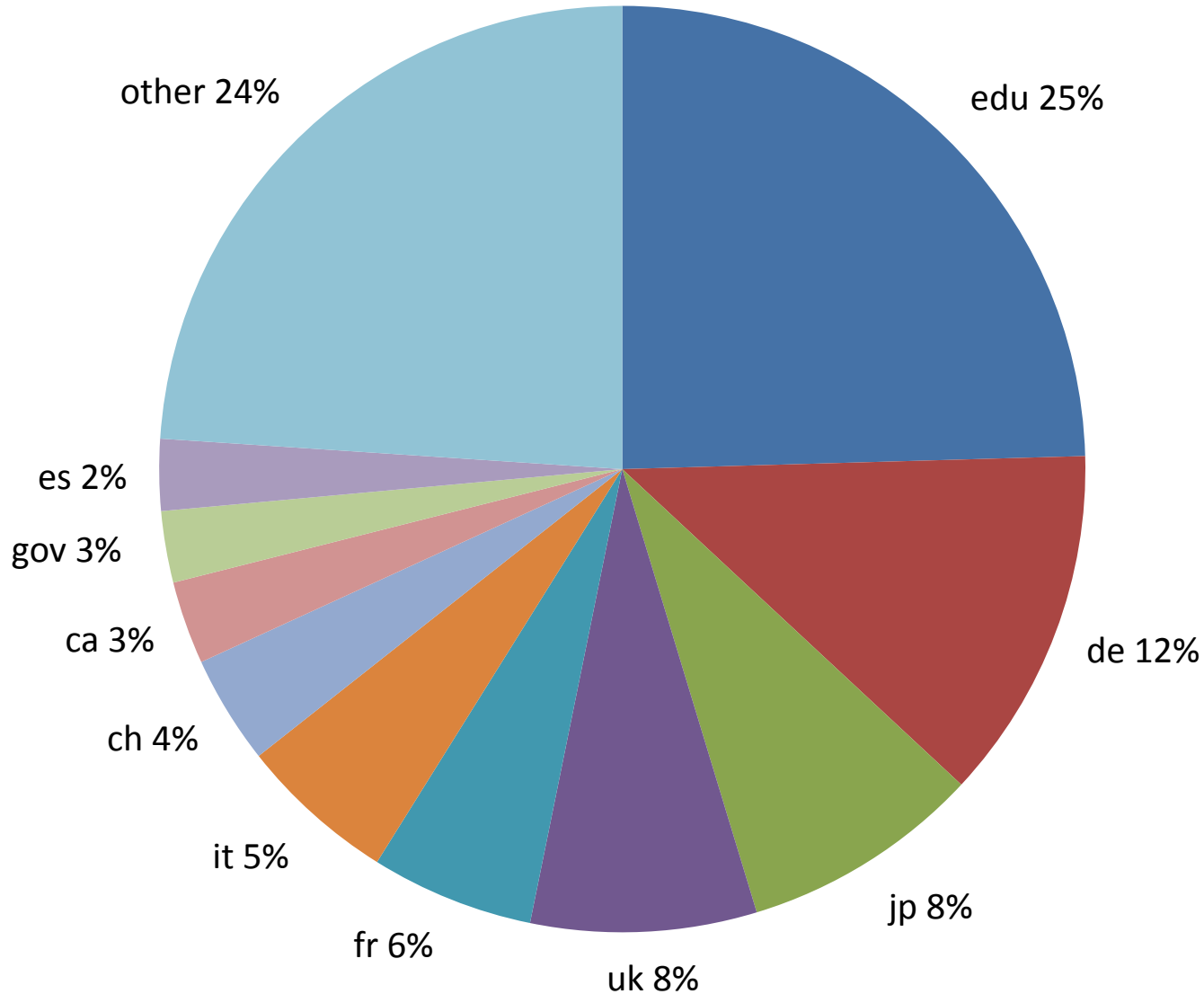
- arXiv is an open access service, free to submitters and users alike
- arXiv is a culturally embedded resource that provides value to a global network of science researchers
- arXiv complements, rather than competes with, the commercial and scholarly society journal publishing market
- Keeping arXiv sustainable involves not only covering the operational costs but also continuing to enhance its value based on the needs of the user community



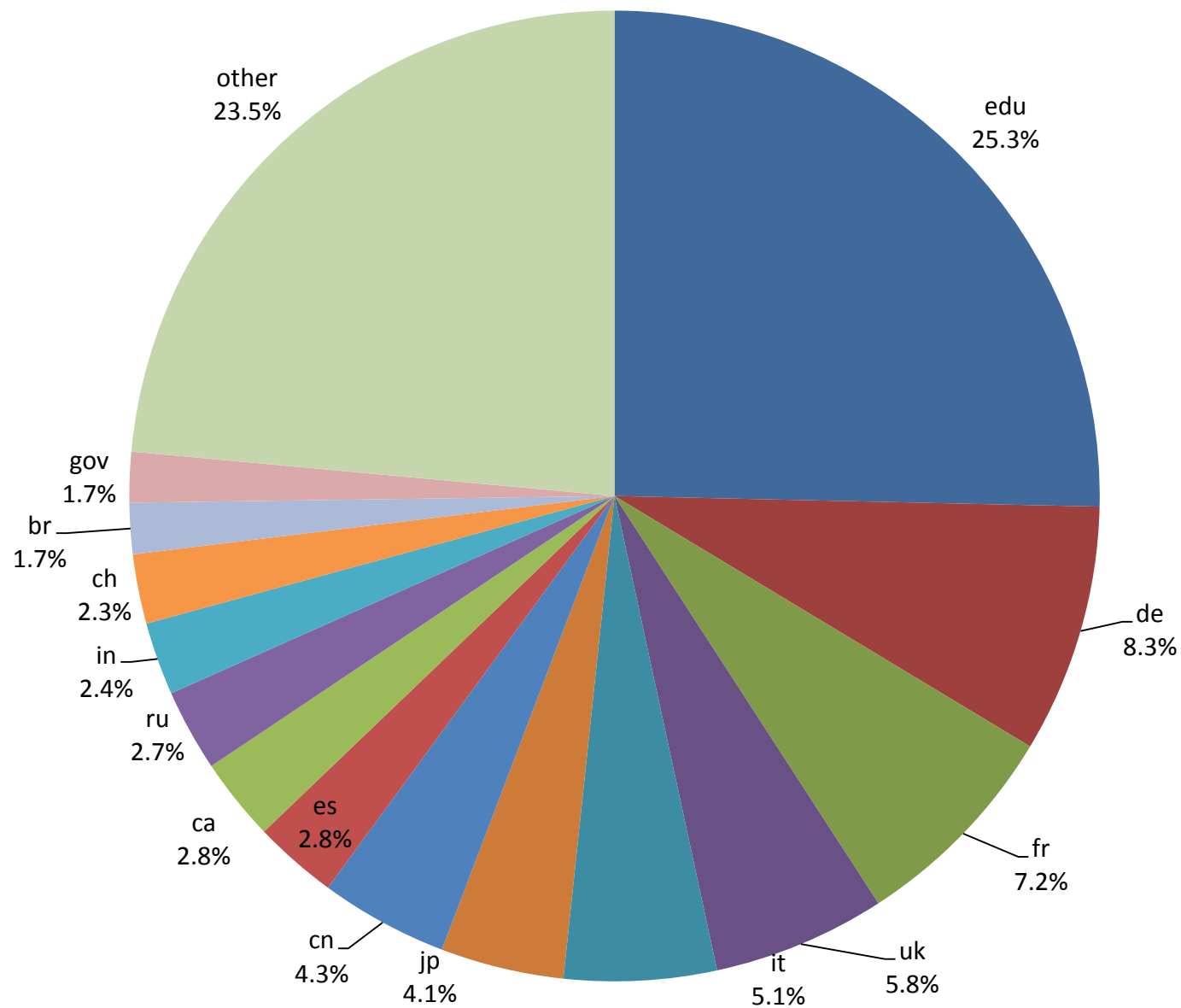
Fraction of arXiv submissions by subject area



2010 Institutional Downloads by Domain Name



Oct 2010 arXiv submissions, by submitter's primary domain (sample statistics)



Sustainability Planning

INTERIM MODEL, 2010-2013

*Developed a 3-year collaborative support model requesting **voluntary** contributions from libraries and research institutes*

- Target the top 200 based on downloads from institutional domain names
 - Annual contribution tiers per institution: \$4,000 \$3,200 \$2,300
 - MOUs with key partners including UK/JISC, TIB, Helmholtz, Max Planck, Japan
- 2010 - \$360,000 in contributions from 123 institutions representing 11 countries
- 2011 - \$368,600 in contributions from 124 institutions representing 14 countries (estimated budget: ~ \$480,000)
- CUL covers 15% of annual expenses plus indirect costs (35% of direct)
 - CY11 – CUL's share is \$72,000 direct plus \$168,000 indirect

ARXIV BUDGET - CALENDAR YEAR 2010

	Projected Budget	Actual
REVENUE		
Institutional supporters		335,882
Cornell University Library contribution		46,747
TOTAL REVENUE		\$382,629
EXPENSES		
Personnel (including benefits)		
User support	2 FTE + 0.36 student	
Programming and system maintenance	1.00 FTE ³	
Administrative and business model support	0.35 FTE ⁴	
Management	0.50 FTE ⁵	
	<i>Subtotal Personnel</i>	
	\$313,700	\$258,052
Non-Personnel		
Server amortization, hosting, hardware maintenance, storage and backup ⁶	41,100	28,262
Network bandwidth and telephony	18,500	12,723
Staff computers, software and supplies	2,500	5,884
Staff conference/meeting attendance, and arXiv Sustainability Group travel	15,000	6,723
Third-party preservation fees ⁷	8,000	
	<i>Subtotal Non-Personnel</i>	
	85,100	53,592
TOTAL DIRECT EXPENSES	\$398,800	\$311,644
Indirect and In-kind Costs		
College and department administration, staff support (22% of direct costs) ¹	87,736	68,562
Facilities (13% of direct costs) ²	51,844	40,514
arXiv moderation (130+ moderators, varying time commitments)		
	<i>Subtotal Indirect Costs</i>	
	\$139,580	\$109,075
TOTAL EXPENSES	\$538,380	\$420,719
2010 Surplus (total revenue less total direct expenses)		\$70,985

1/2010 - 9/2011: Planning Outcomes

Review and stabilize arXiv staffing and organization:

- Define roles for management, IT development, and user support with clear lines of reporting and responsibility
- Establish a sustainability advisory group and start streamlining communication with the scientific advisory group
- Track associated direct costs and make this information available on the website
- Structure the arXiv budget within CUL accounting as a grant-funded account in order to adhere to Cornell's financial policies and to provide audit track
- Start transitioning daily moderation role from Paul Ginsparg to CUL

1/2010 - 9/2011: Planning Outcomes

Evaluate arXiv's IT infrastructure

- Develop and assess a plan for migrating the 20-year old search and display architecture to Invenio (open sources digital library platform)
- Sign an agreement with CERN to collaborate on further development and maintenance of Invenio
- Assess the preservation status of arXiv and consider CUL's archival repository, Portico, and CLOCKSS
- Participate in the ORCID initiative, which aims to alleviate author/contributor name ambiguity and ultimately improve the efficiency of research funding and collaboration within research communities

1/2010 - 9/2011: Planning Outcomes

Evaluate arXiv's functionality and user support

- Start planning a usability study in support of Invenio-related web interface changes
- Initiate a review of arXiv user guides and help pages
- Participate in NSY-funded Data Conservancy pilot to enable uploading of data associated with arXiv articles (article is stored on arXiv, data is automatically deposited in the Data Conservancy repository and linked from the article)
- Analyze arXiv use statistics and usage patterns
 - ✓ Sample submission-based statistics to compare institutional use and submissions (similar pattern)
 - ✓ Based on an analysis of 1,000 arXiv papers, sample representation of NSF-funded research paper in arXiv (~10%)

1/2010 - 9/2011: Planning Outcomes

- Implement a three-year interim plan for seeking contributions from top 200 institutions with heavy use
 - Negotiate MOUs with JISC, TIB, Helmholtz, Max Planck
 - Continue to work on institutional arrangements with SPARC Japan and DoE
 - Develop a communication strategy to seek contributions from individual institutions (both US and international)
- Hold discussions with a group of publishers and societies to discuss how to include them in the business planning process
 - Interest in creating a funding pool in support of arXiv R&D such as data support and better linking among versions (e-print to published version)

1/2010 - 9/2011: Planning Outcomes

- Communicate business planning activities through quarterly updates and periodic conference calls open to all interested parties
- Explore potential legal status options to establish a community-based structure and procedures for strategic, operational, and fiscal oversight
- Secure a grant in support of governance planning efforts

Goals of Governance Planning Process

- Delineate a governance model and bylaws that clearly define roles and responsibilities for CUL and the collaborating partners
- Establish a governance system reflecting the scientific community represented by arXiv and financial contribution levels of major stakeholders
- Propose a set of arXiv operating principles and seek input from key stakeholders to ensure a stable, collaborative governance structure for arXiv
- Refine the institutional fee model and revenue projection
- Test the sensitivity of the financial and organizational model of arXiv under various revenue and cost scenarios.

Legal Status Options

arXiv incorporates as a distinct legal entity with no affiliation with Cornell University

- **Advantage:** Would allow the broadest range of possible arXiv governance structures
- **Disadvantage:** Significant increase in direct annual costs and loss of Cornell legal and tax protection
- **Disadvantage:** Disassociation with Cornell, which has been instilling trust and stability since 2001

arXiv remains wholly owned by Cornell University

- **Advantage:** Cost savings and Cornell's legal and tax protection
- **Advantage:** Cornell's reputation as a stable higher education institution
- **Advantage:** Potential operational flexibility and efficiencies, as CUL is able to draw on experience and resources supporting other Library operations
- **Disadvantage:** Would require the development and maintenance of a clear and compelling governance structure and by-laws in support of community-based oversight

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Additional information at:

<http://arxiv.org/help/support>