Science Communication and Literature Searches

If a supernova explodes in the galaxy and no one observes it does it make a flash?

If a supernova explodes in the galaxy and someone observes it, but nobody publishes it, does it make a flash?

- Scientific "success" rest on the quality, but also the visibility, of your work.
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Whether writing a paper or giving a talk, be mindful of the composition of your audience. Frame and structure your presentation accordingly. Are they…

- Experts in the subject at hand?
- Experts in the relevant astronomy sub-field?
- Members of the astronomical community?
- Physicists?
- A proposal review panel that might include any combination of the above?
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- Non-scientists: e.g., non-science media, members of congress, the public at large, schoolchildren..?

The technical level, and amount of amount of background material, depend on the audience, setting, and format.

Let's suppose that you've just completed a major project involving X-ray observations of Active Galactic Nuclei (AGN)…

There are also time and space (page limits) considerations.

Venue	Level	Background
AGN Conference	Very Technical	None
X-ray Astronomy Conference	Very Technical	Little
Astronomy Conference, Journal Article	Very Technical	Some
Physics Seminar, Job Talk	Very Technical	Lots
Astr288c Class Project	Technical	Some
Observing Proposal	Technical	Lots
Funding Proposal	Somewhat Technical	Lots
Sky & Tel Article or Interview	Slightly Technical	Some
Press Release or Press Conference	Non-technical	Lots
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Writing and Publishing Papers: The Literature

The scientific literature includes non-technical (newspaper, magazine) articles and books, and conference proceedings. Original research results are generally published in **peer-reviewed** journals such as *AJ*, *ApJ*, *A&A*, *MNRAS*, *PASJ*, *PASP, ARAA, Science*, *Nature*.

Type of Paper	Length	Content
Letter	Short	Timely, significant result
Standard Article	Open	Open
Supplement	Long	Details of a long program, new technique…
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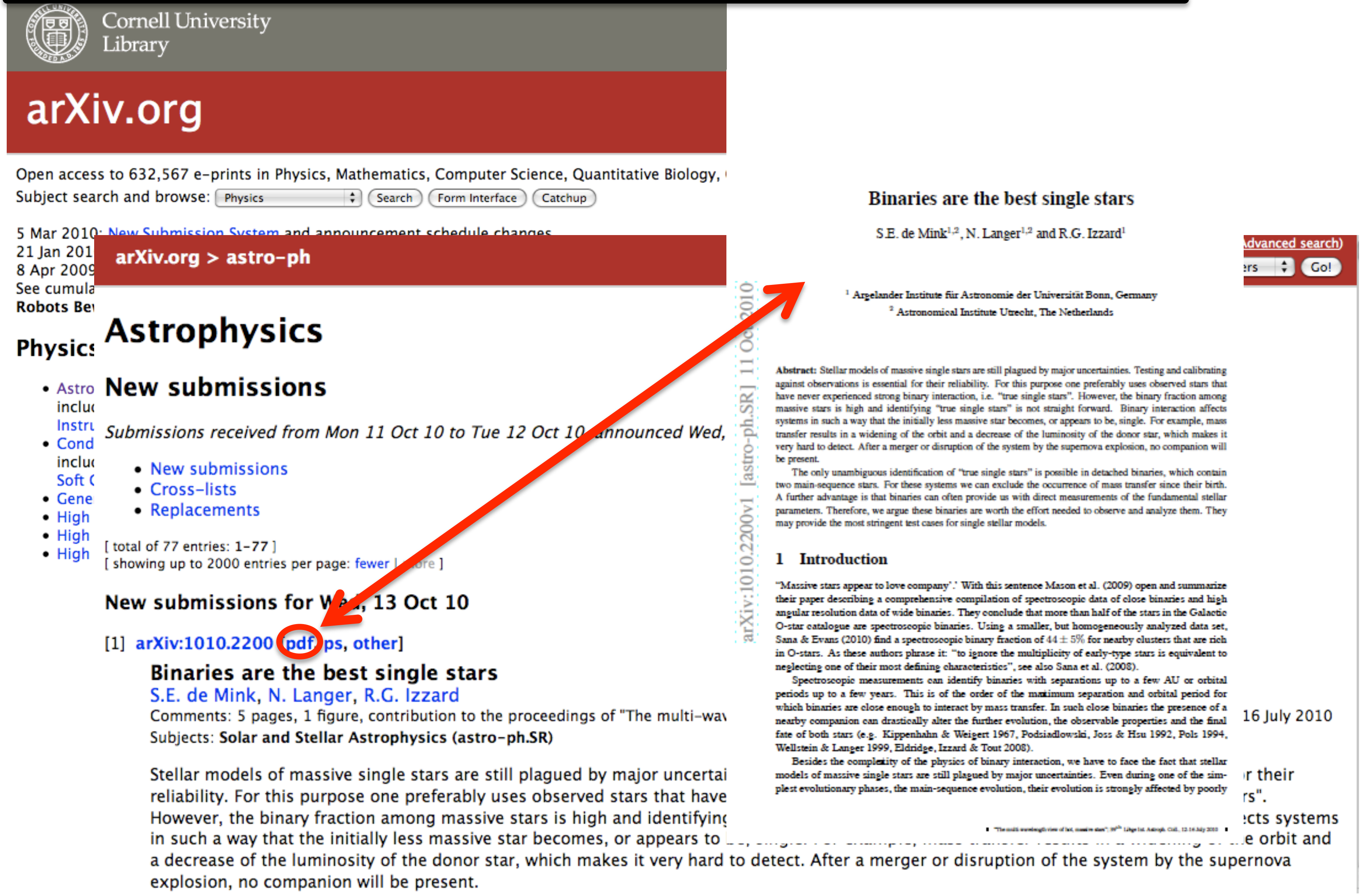

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Astrophysics

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Submissions received from Mon 11 Oct 10 to Tue 12 Oct 10, announced Wed,

- New submissions
- Cross-lists
- Replacements

[total of 77 entries: 1-77]
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New submissions for Wed, 13 Oct 10

[1] arXiv:1010.2200 [pdf, ps, other]

Binaries are the best single stars

S.E. de Mink, N. Langer, R.G. Izzard

Comments: 5 pages, 1 figure, contribution to the proceedings of "The multi-wav

Subjects: **Solar and Stellar Astrophysics (astro-ph.SR)**

Stellar models of massive single stars are still plagued by major uncertai
reliability. For this purpose one preferably uses observed stars that have
However, the binary fraction among massive stars is high and identifying
in such a way that the initially less massive star becomes, or appears to
a decrease of the luminosity of the donor star, which makes it very hard to detect. After a merger or disruption of the system by the supernova explosion, no companion will be present.

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arXiv:1010.2200v1 [astro-ph.SR] 11 Oct 2010

Binaries are the best single stars

S.E. de Mink[1,2], N. Langer[1,2] and R.G. Izzard[1]

[1] Argelander Institute für Astronomie der Universität Bonn, Germany
[2] Astronomical Institute Utrecht, The Netherlands

Abstract: Stellar models of massive single stars are still plagued by major uncertainties. Testing and calibrating against observations is essential for their reliability. For this purpose one preferably uses observed stars that have never experienced strong binary interaction, i.e. "true single stars". However, the binary fraction among massive stars is high and identifying "true single stars" is not straight forward. Binary interaction affects systems in such a way that the initially less massive star becomes, or appears to be, single. For example, mass transfer results in a widening of the orbit and a decrease of the luminosity of the donor star, which makes it very hard to detect. After a merger or disruption of the system by the supernova explosion, no companion will be present.

The only unambiguous identification of "true single stars" is possible in detached binaries, which contain two main-sequence stars. For these systems we can exclude the occurrence of mass transfer since their birth. A further advantage is that binaries can often provide us with direct measurements of the fundamental stellar parameters. Therefore, we argue these binaries are worth the effort needed to observe and analyze them. They may provide the most stringent test cases for single stellar models.

1 Introduction

"Massive stars appear to love company'.' With this sentence Mason et al. (2009) open and summarize their paper describing a comprehensive compilation of spectroscopic data of close binaries and high angular resolution data of wide binaries. They conclude that more than half of the stars in the Galactic O-star catalogue are spectroscopic binaries. Using a smaller, but homogeneously analyzed data set, Sana & Evans (2010) find a spectroscopic binary fraction of $44 \pm 5\%$ for nearby clusters that are rich in O-stars. As these authors phrase it: "to ignore the multiplicity of early-type stars is equivalent to neglecting one of their most defining characteristics", see also Sana et al. (2008).

Spectroscopic measurements can identify binaries with separations up to a few AU or orbital periods up to a few years. This is of the order of the maximum separation and orbital period for which binaries are close enough to interact by mass transfer. In such close binaries the presence of a nearby companion can drastically alter the further evolution, the observable properties and the final fate of both stars (e.g. Kippenhahn & Weigert 1967, Podsiadlowski, Joss & Hsu 1992, Pols 1994, Wellstein & Langer 1999, Eldridge, Izzard & Tout 2008).

Besides the complexity of the physics of binary interaction, we have to face the fact that stellar models of massive single stars are still plagued by major uncertainties. Even during one of the simplest evolutionary phases, the main-sequence evolution, their evolution is strongly affected by poorly

…and often appear in multiple updated versions.

Replacements for Fri, 15 Oct 10

[41] arXiv:1003.0693 (replaced) [pdf, ps, other]

Large scale outflows from z ~ 0.7 starburst galaxies identified via ultra-strong MgII quasar absorption lines

Daniel B. Nestor, Benjamin D. Johnson, Vivienne Wild, Brice Ménard, David A. Turnshek, Sandhya Rao, Max Pettini

Comments: 15 pages, 6 figure, accepted for publication by MNRAS

Subjects: **Cosmology and Extragalactic Astrophysics (astro-ph.CO)**

[42] arXiv:1004.2496 (replaced) [pdf, ps, other]

Early supernovae light-curves following the shock-breakout

Ehud Nakar, Re'em Sari

Comments: ApJ in press

Subjects: **High Energy Astroph**

[43] arXiv:1005.3847 (replaced)

Star Formation in the

Sun Mi Chung, Anthony H

Comments: 17 pages, 12 figure

Subjects: **Cosmology and Extr**

[44] arXiv:1005.4554 (replaced)

INTEGRAL, Swift, and J1749.4-2807

C. Ferrigno, E. Bozzo, M. I

Large scale outflows from z ~ 0.7 starburst galaxies identified via ultra-strong MgII quasar absorption lines

Daniel B. Nestor, Benjamin D. Johnson, Vivienne Wild, Brice Ménard, David A. Turnshek, Sandhya Rao, Max Pettini

(Submitted on 3 Mar 2010 (v1), last revised 14 Oct 2010 (this version, v2))

(Abridged) Star formation-driven outflows are a critical phenomenon in theoretical treatments of galaxy evolution, despite the limited ability of observations to trace them across cosmological timescales. If the strongest MgII absorption-line systems detected in the spectra of background quasars arise in such outflows, "ultra-strong" MgII (USMgII) absorbers would identify significant numbers of galactic winds over a huge baseline in cosmic time, in a manner independent of the luminous properties of the galaxy. To this end, we present the first detailed imaging and spectroscopic study of the fields of two USMgII absorber systems culled from a statistical absorber catalog, with the goal of understanding the physical processes leading to the large velocity spreads that define such systems. Each field contains two bright emission-line galaxies at similar redshift (dv < 300 km/s) to that of the absorption. Lower-limits on their instantaneous star formation rates (SFR) from the observed OII and Hb line fluxes, and stellar masses from spectral template fitting indicate specific SFRs among the highest for their masses at z~0.7. Additionally, their 4000A break and Balmer absorption strengths imply they have undergone recent (~0.01 - 1 Gyr) starbursts. The concomitant presence of two rare phenomena - starbursts and USMgII absorbers - strongly implies a causal connection. We consider these data and USMgII absorbers in general in the context of various popular models, and conclude that galactic outflows are generally necessary to account for the velocity extent of the absorption. We favour starburst driven outflows over tidally-stripped gas from a major interaction which triggered the starburst as the energy source for the majority of systems. Finally, we discuss the implications of these results and speculate on the overall contribution of such systems to the global SFR density at z~0.7.

Comments:	15 pages, 6 figure, accepted for publication by MNRAS
Subjects:	**Cosmology and Extragalactic Astrophysics (astro-ph.CO)**
Cite as:	arXiv:1003.0693v2 [astro-ph.CO]

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From: Daniel Nestor [view email]

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[v2] Thu, 14 Oct 2010 02:25:03 GMT (1817kb)

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[41] arXiv:1003.0693 (replaced) [pdf, ps, other]

Large scale outflows from z ~ 0.7 starburst gala
absorption lines

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J1749.4-2807

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Daniel B. Nestor, Benjamin D. Johnson, V

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Mon. Not. R. Astron. Soc. 000, 1–18 (2010) Printed 15 October 2010 (MN LaTeX style file v2.2)

Large scale outflows from $z \simeq 0.7$ starburst galaxies identified via ultra-strong MgII quasar absorption lines.

Daniel B. Nestor[1,2*], Benjamin D. Johnson[1], Vivienne Wild[3], Brice Ménard[4],
David A. Turnshek[5], Sandhya Rao[5] and Max Pettini[1,6]

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[2] *Department of Physics and Astronomy, University of California, Los Angeles, CA 90095-1547, USA*
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[4] *Canadian Institute for Theoretical Astrophysics, University of Toronto, 60 St. George Street, Toronto, Ontario, M5S 3H8, Canada*
[5] *Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, PA 15260, USA*
[6] *International Centre for Radio Astronomy Research, University of Western Australia, 35 Stirling Highway, Crawley, WA 6009, Australia*

ABSTRACT

Star formation-driven outflows are a critically important phenomenon in theoretical treatments of galaxy evolution, despite the limited ability of observational studies to trace galactic winds across cosmological timescales. It has been suggested that the strongest Mg II absorption-line systems detected in the spectra of background quasars might arise in outflows from foreground galaxies. If confirmed, such "ultra-strong" Mg II (USMgII) absorbers would represent a method to identify significant numbers of galactic winds over a huge baseline in cosmic time, in a manner independent of the luminous properties of the galaxy. To this end, we present the first detailed imaging and spectroscopic study of the fields of two USMgII absorber systems culled from a statistical absorber catalog, with the goal of understanding the physical processes leading to the large velocity spreads that define such systems.

Each field contains two bright emission-line galaxies at similar redshift ($\Delta v \lesssim 300$ km s^{-1}) to that of the absorption. Lower-limits on their instantaneous star formation rates (SFR) from the observed [O II] and Hβ line fluxes, and stellar masses from spectral template fitting indicate specific SFRs among the highest for their masses at these redshifts. Additionally, their 4000Å break and Balmer absorption strengths imply they have undergone recent (~ 0.01 - 1 Gyr) starbursts. The concomitant presence of two rare phenomena – starbursts and USMgII absorbers – strongly implies a causal connection. We consider these data and USMgII absorbers in general in the context of various popular models, and conclude that galactic outflows are generally necessary to account for the velocity extent of the absorption. We favour starburst driven outflows over tidally-stripped gas from a major interaction which triggered the starburst as the energy source for the majority of systems. Finally, we discuss the implications of these results and speculate on the overall contribution of such systems to the global SFR density at $z \simeq 0.7$.

Key words: intergalactic medium – quasars: absorption lines – ISM: jets and outflows – galaxies: starburst.

1 INTRODUCTION

In the local Universe, large scale gas outflows are observed to arise in galaxies exhibiting high surface densities of star formation. While the precise roles of such outflows, including galactic "superwinds", in galaxy evolution are still being determined, simulations suggest that the balance between outflows and the accretion of cool gas is one of the primary mechanisms by which star formation is regulated in individual halos (e.g., Oppenheimer et al., 2009; Brooks et al., 2009). At the current epoch, the highest star formation rate (SFR) surface densities – and therefore galactic winds – are preferentially found in relatively low-mass halos, such as those hosting dwarf starburst galaxies. However, the mass

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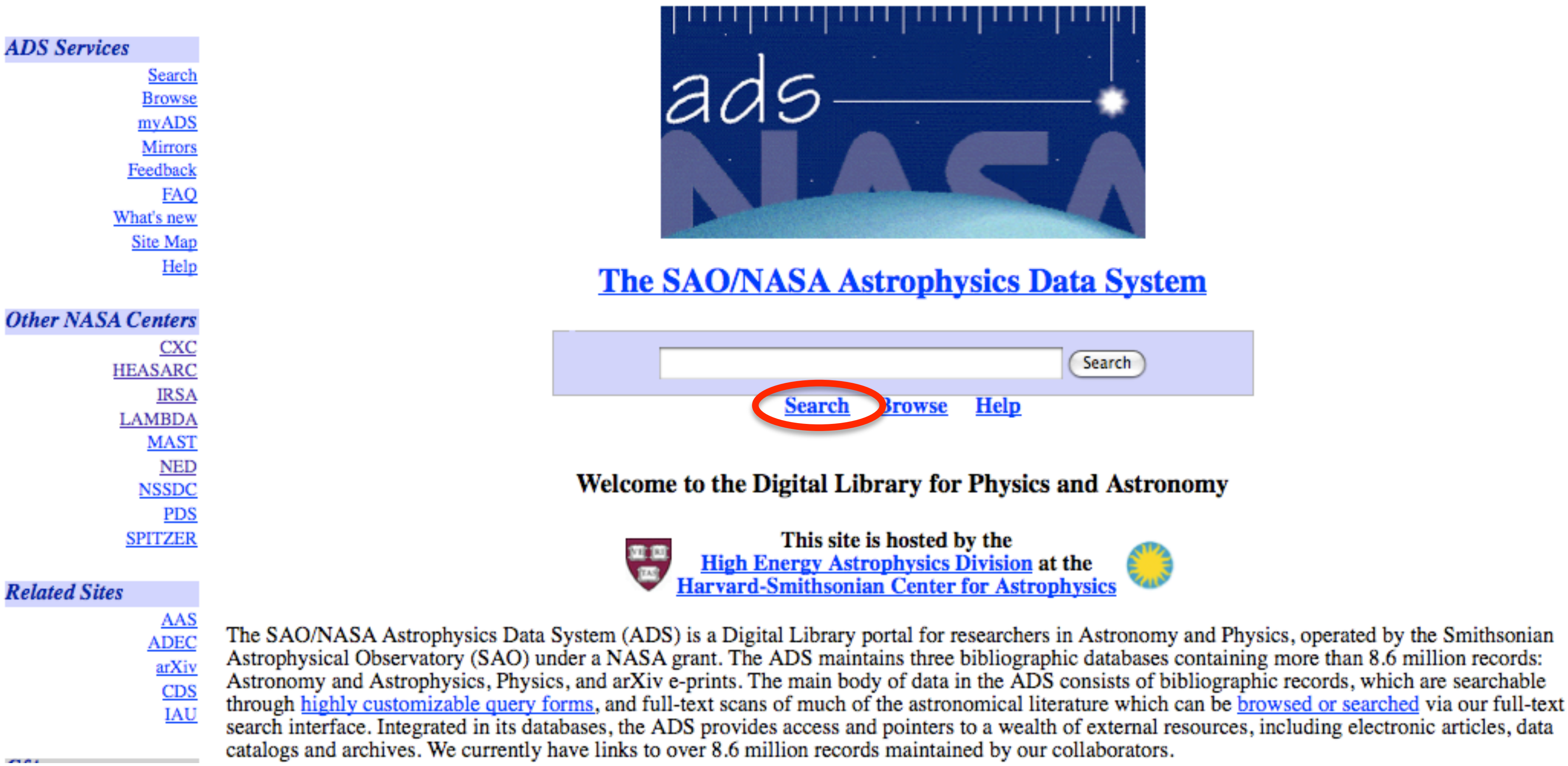

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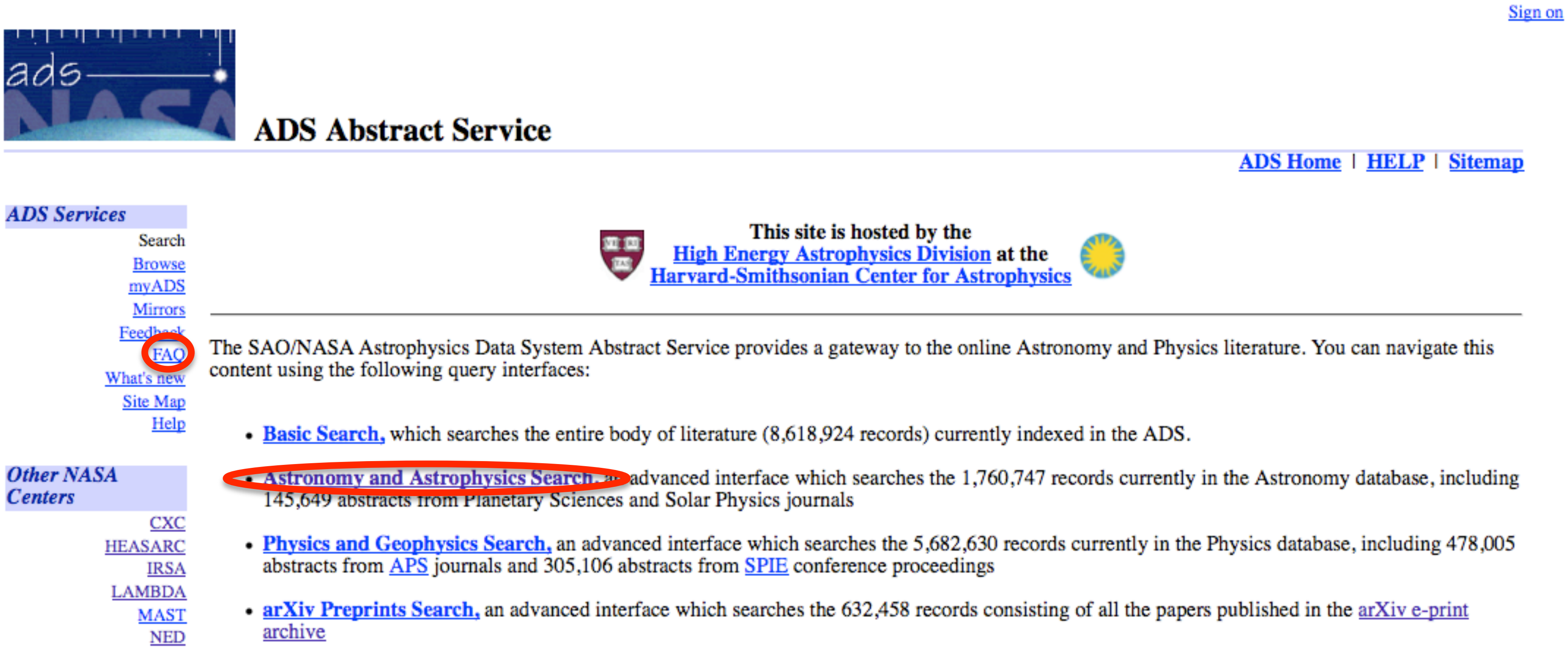

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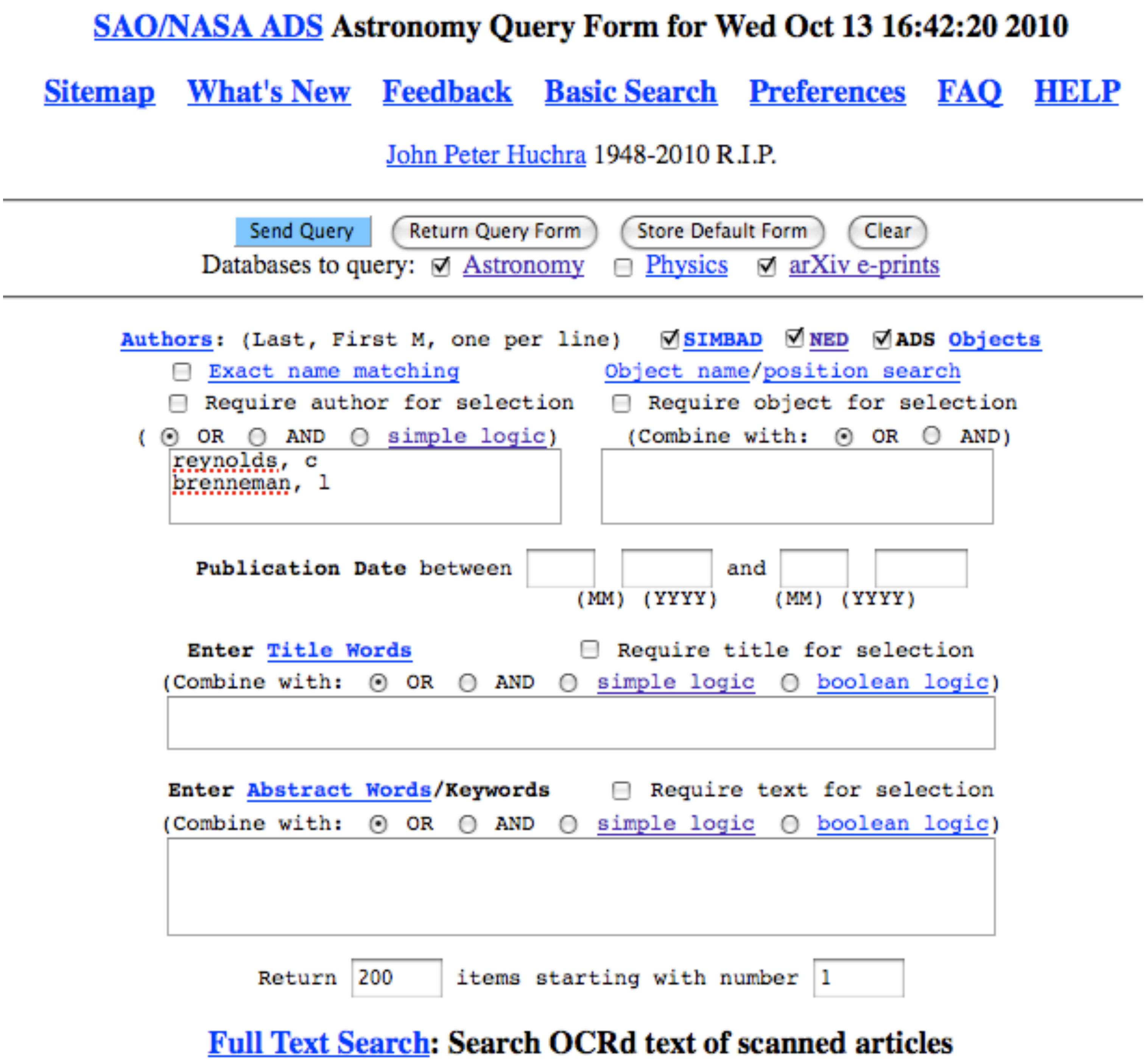

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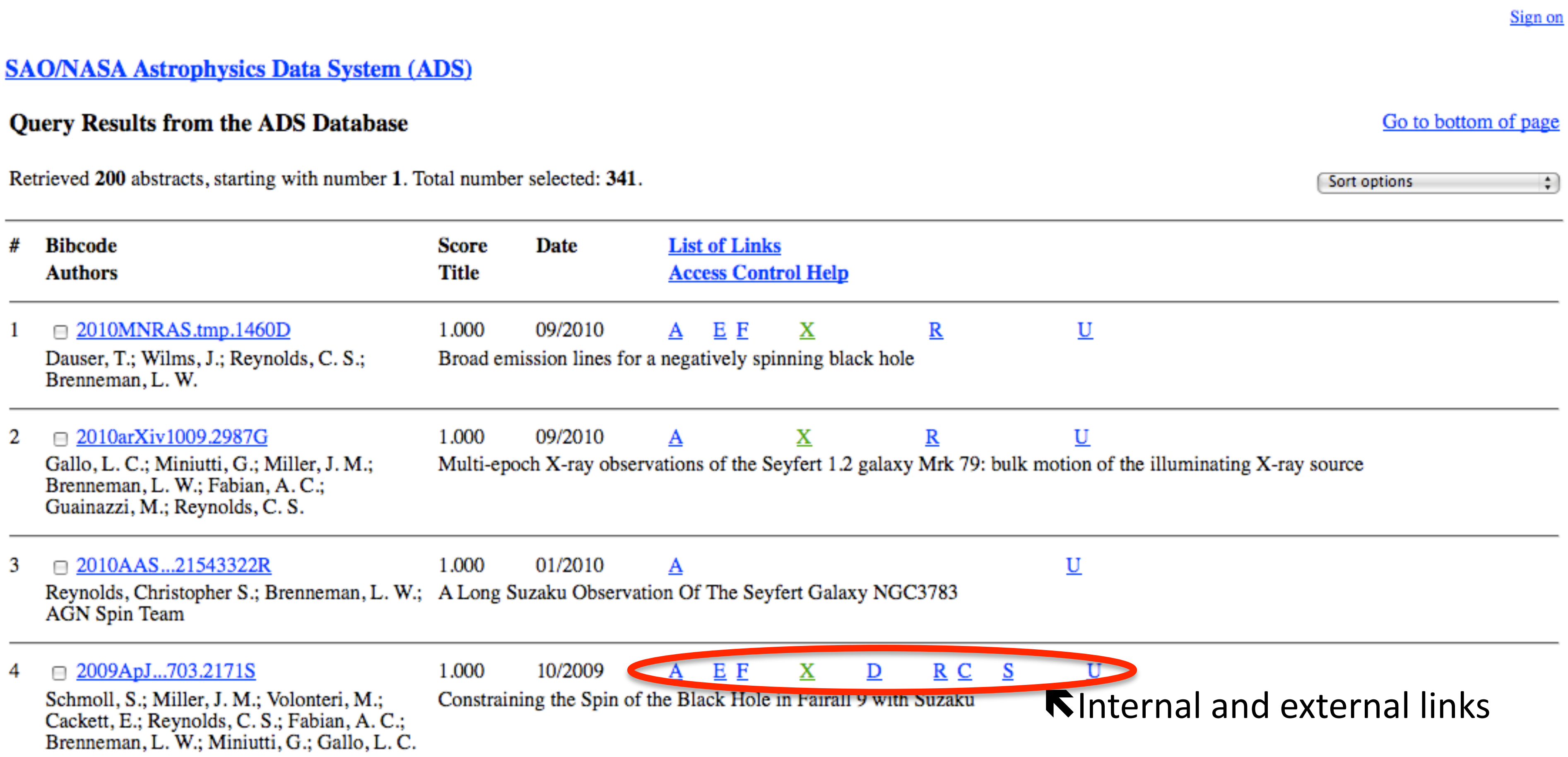

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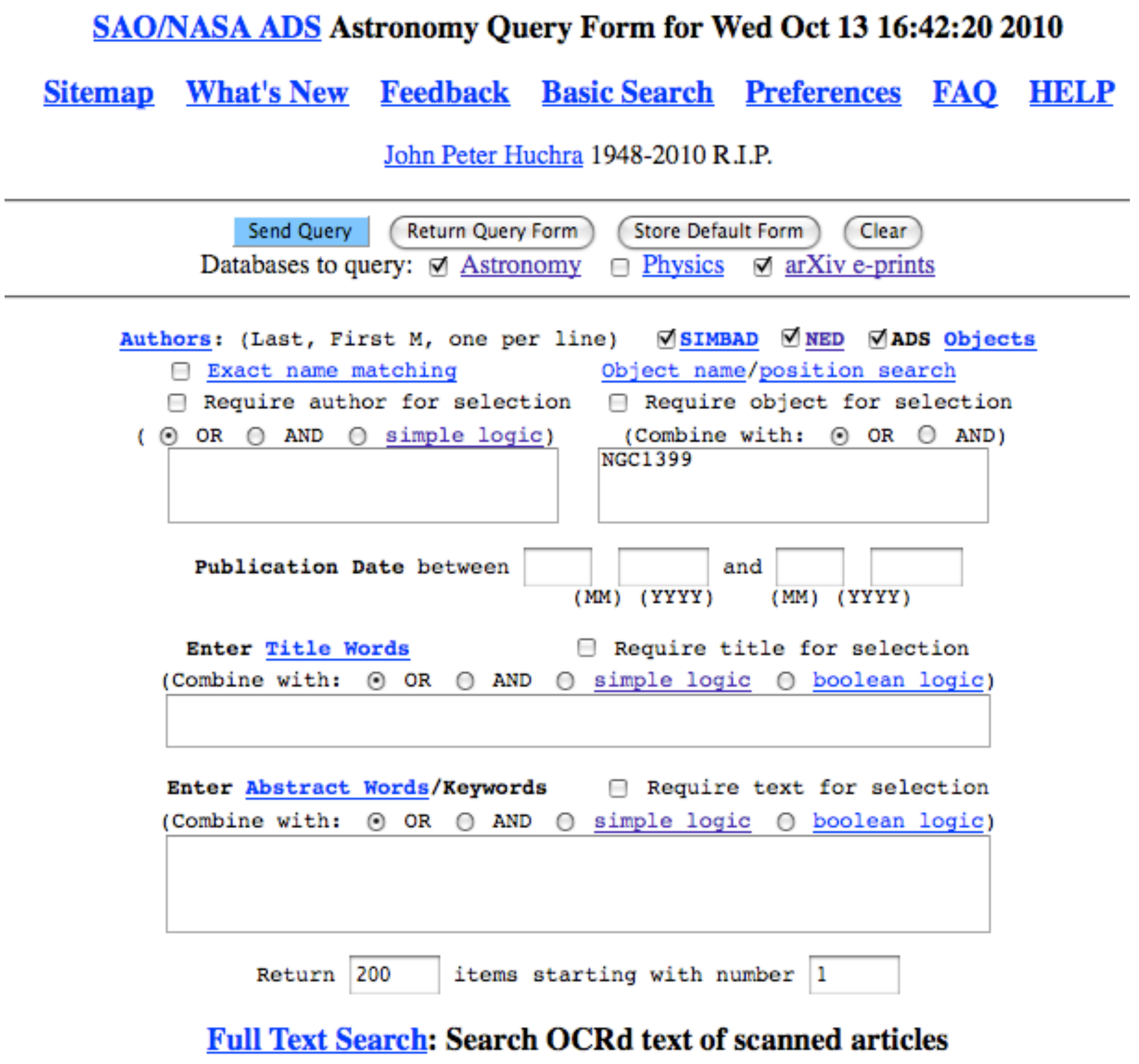

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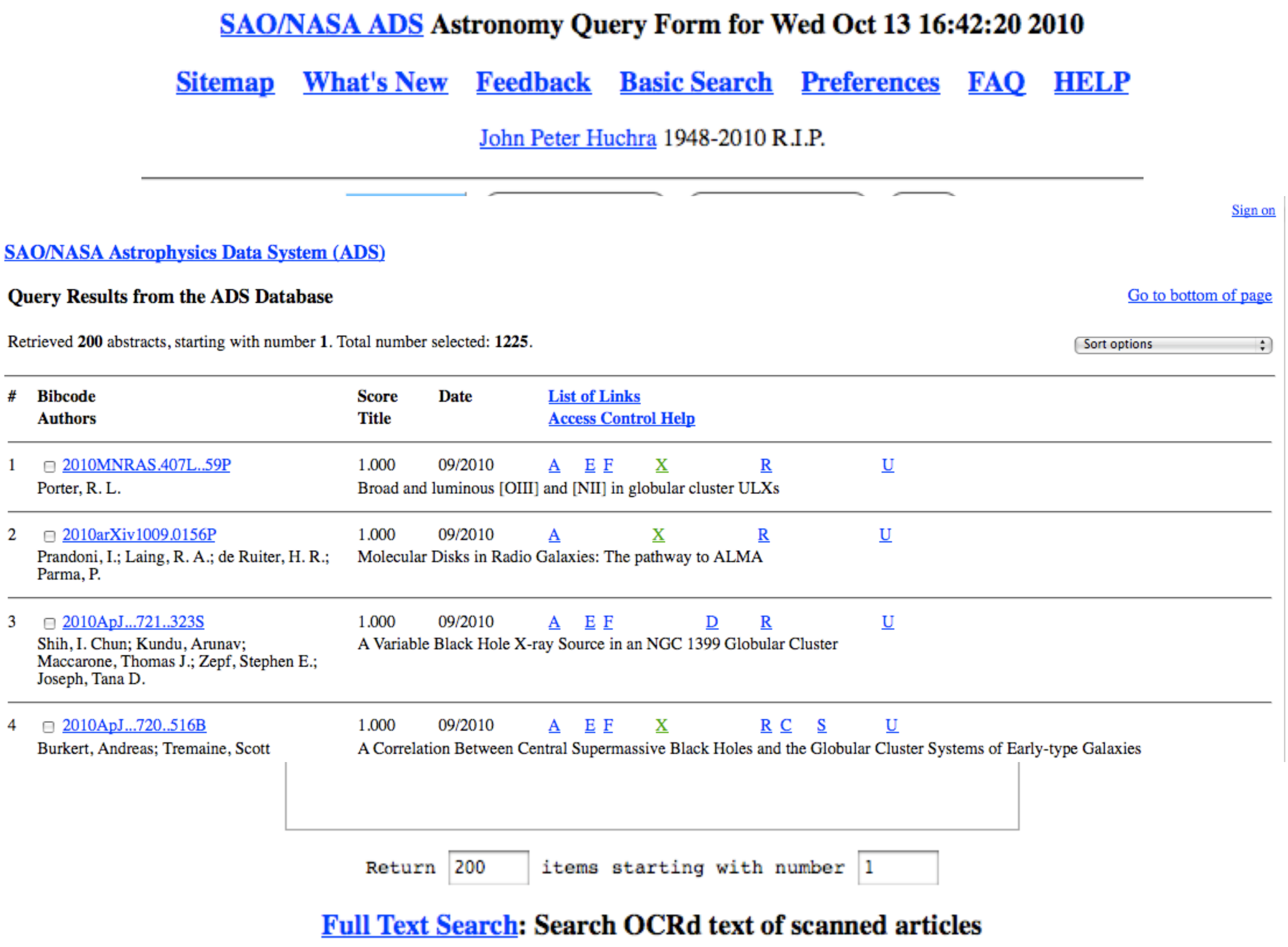

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Writing and Publishing Papers: Content

The Astrophysical Journal, 620:680–696, 2005 February 20
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INTERMEDIATE-ELEMENT ABUNDANCES IN GALAXY CLUSTERS

W. H. Baumgartner,[1,2,3] M. Loewenstein,[1,2] D. J. Horner,[2] and R. F. Mushotzky[2]

Received 2003 May 2; accepted 2004 October 28

ABSTRACT

We present the average abundances of the intermediate elements obtained by performing a stacked analysis of all the galaxy clusters in the archive of the X-ray telescope *ASCA*. We determine the abundances of Fe, Si, S, and Ni as a function of cluster temperature (mass) from 1–10 keV and place strong upper limits on the abundances of Ca and Ar. In general, Si and Ni are overabundant with respect to Fe, while Ar and Ca are very underabundant. The discrepancy between the abundances of Si, S, Ar, and Ca indicate that the α-elements do not behave homogeneously as a single group. We show that the abundances of the most well-determined elements Fe, Si, and S in conjunction with recent theoretical supernova yields do not give a consistent solution for the fraction of material produced by Type Ia and Type II supernovae at any temperature or mass. The general trend is for higher temperature clusters to have more of their metals produced in Type II supernovae than in Type Ia supernovae. The inconsistency of our results with abundances in the Milky Way indicate that spiral galaxies are not the dominant metal contributors to the intracluster medium (ICM). The pattern of elemental abundances requires an additional source of metals beyond standard Type Ia and Type II supernova enrichment. The properties of this new source are well matched to those of Type II supernovae with very massive, metal-poor progenitor stars. These results are consistent with a significant fraction of the ICM metals produced by an early generation of Population III stars.

Subject headings: galaxies: abundances — intergalactic medium — supernovae: general — X-rays: galaxies: clusters

Online material: color figures

1. INTRODUCTION

Galaxy clusters provide an excellent environment for determining the relative abundances of the elements. Because clusters are the largest potential wells known, they retain all the enriched material produced by the member galaxies. This behavior is in stark contrast to our own Milky Way (Timmes et al. 1995) and many other individual galaxies (Henry & Worthey 1999). The accumulation of enriched material in clusters can be used as a probe to study the star formation history of the universe … lie in the X-ray band. This makes the X-ray band an attractive place for elemental-abundance determinations.

Early X-ray observations of galaxy clusters (Mitchell et al. 1976; Serlemitsos et al. 1977) showed that the strong H- and He-like iron lines at 6.9 and 6.7 keV could lead to a value for the metal abundance in clusters. Later results (Mushotzky et al. 1978; Mushotzky 1984) derived from iron-line observations showed that clusters had metal abundances of about one-third the solar value.

The improved spectral resolution and large collecting area of

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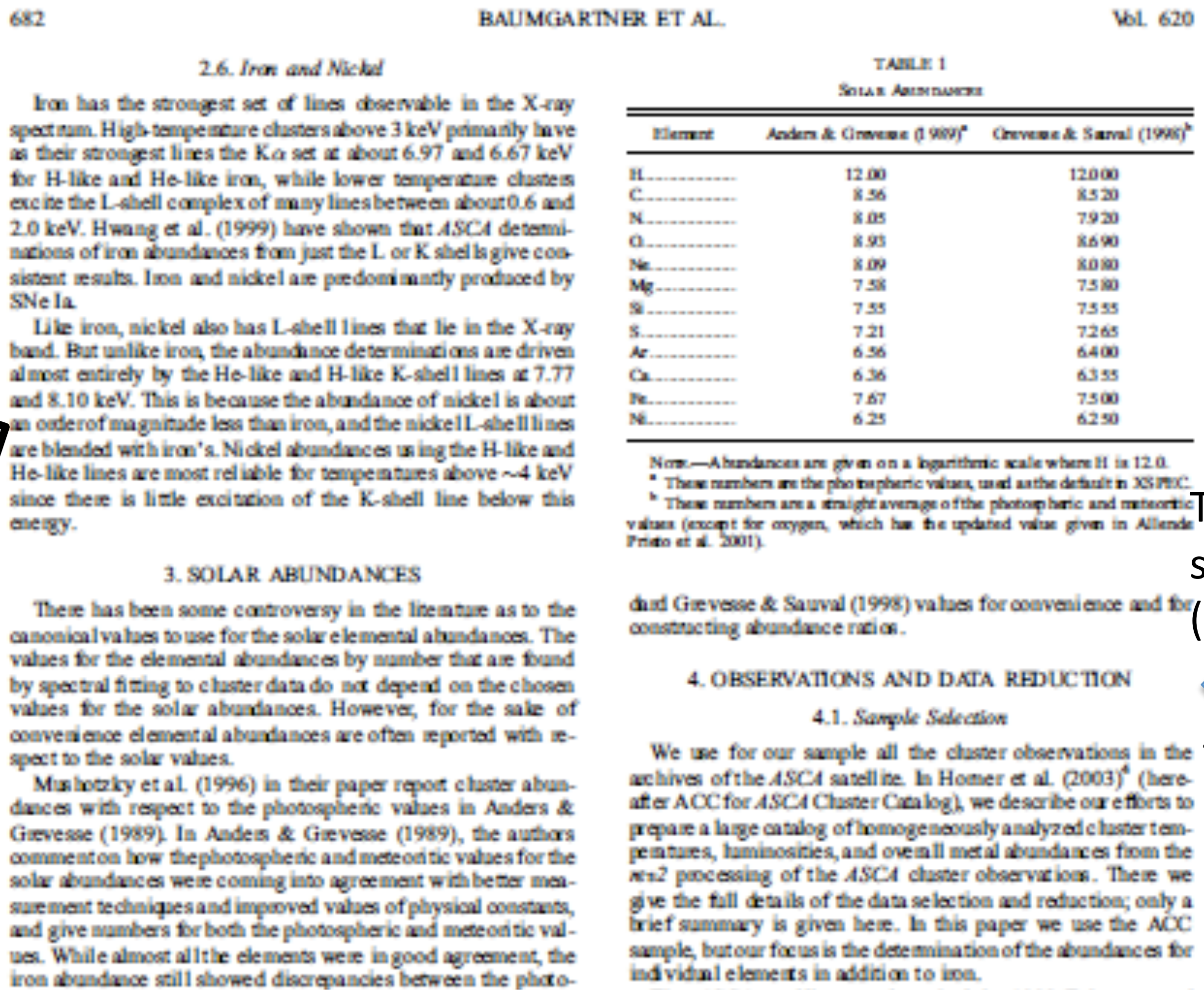
Be complete, but brief!

Context counts!



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2.6. *Iron and Nickel*

Iron has the strongest set of lines observable in the X-ray spectrum. High-temperature clusters above 3 keV primarily have as their strongest lines the Kα set at about 6.97 and 6.67 keV for H-like and He-like iron, while lower temperature clusters excite the L-shell complex of many lines between about 0.6 and 2.0 keV. Hwang et al. (1999) have shown that *ASCA* determinations of iron abundances from just the L or K shells give consistent results. Iron and nickel are predominantly produced by SNe Ia.

Like iron, nickel also has L-shell lines that lie in the X-ray band. But unlike iron, the abundance determinations are driven almost entirely by the He-like and H-like K-shell lines at 7.77 and 8.10 keV. This is because the abundance of nickel is about an order of magnitude less than iron, and the nickel L-shell lines are blended with iron's. Nickel abundances using the H-like and He-like lines are most reliable for temperatures above ~4 keV since there is little excitation of the K-shell line below this energy.

3. SOLAR ABUNDANCES

There has been some controversy in the literature as to the canonical values to use for the solar elemental abundances. The values for the elemental abundances by number that are found by spectral fitting to cluster data do not depend on the chosen values for the solar abundances. However, for the sake of convenience elemental abundances are often reported with respect to the solar values.

Mushotzky et al. (1996) in their paper report cluster abundances with respect to the photospheric values in Anders & Grevesse (1989). In Anders & Grevesse (1989), the authors comment on how the photospheric and meteoritic values for the solar abundances were coming into agreement with better measurement techniques and improved values of physical constants, and give numbers for both the photospheric and meteoritic values. While almost all the elements were in good agreement, the iron abundance still showed discrepancies between the photo-

TABLE 1

Solar Abundances

Element	Anders & Grevesse (1989)[a]	Grevesse & Sauval (1998)[b]
H............	12.00	12.000
C............	8.56	8.520
N............	8.05	7.920
O............	8.93	8.690
Ne............	8.09	8.080
Mg............	7.58	7.580
Si............	7.55	7.555
S............	7.21	7.265
Ar............	6.56	6.400
Ca............	6.36	6.355
Fe............	7.67	7.500
Ni............	6.25	6.250

Note.—Abundances are given on a logarithmic scale where H is 12.0.

[a] These numbers are the photospheric values, used as the default in XSPEC.

[b] These numbers are a straight average of the photospheric and meteoritic values (except for oxygen, which has the updated value given in Allende Prieto et al. 2001).

dard Grevesse & Sauval (1998) values for convenience and for constructing abundance ratios.

4. OBSERVATIONS AND DATA REDUCTION

4.1. *Sample Selection*

We use for our sample all the cluster observations in the archives of the *ASCA* satellite. In Horner et al. (2003)[4] (hereafter ACC for *ASCA* Cluster Catalog), we describe our efforts to prepare a large catalog of homogeneously analyzed cluster temperatures, luminosities, and overall metal abundances from the *rev2* processing of the *ASCA* cluster observations. There we give the full details of the data selection and reduction; only a brief summary is given here. In this paper we use the ACC sample, but our focus is the determination of the abundances for individual elements in addition to iron.

Explain what you did… and why!

There should be sufficient info (directly/indirectly) that your results can, in principle, be reproduced.

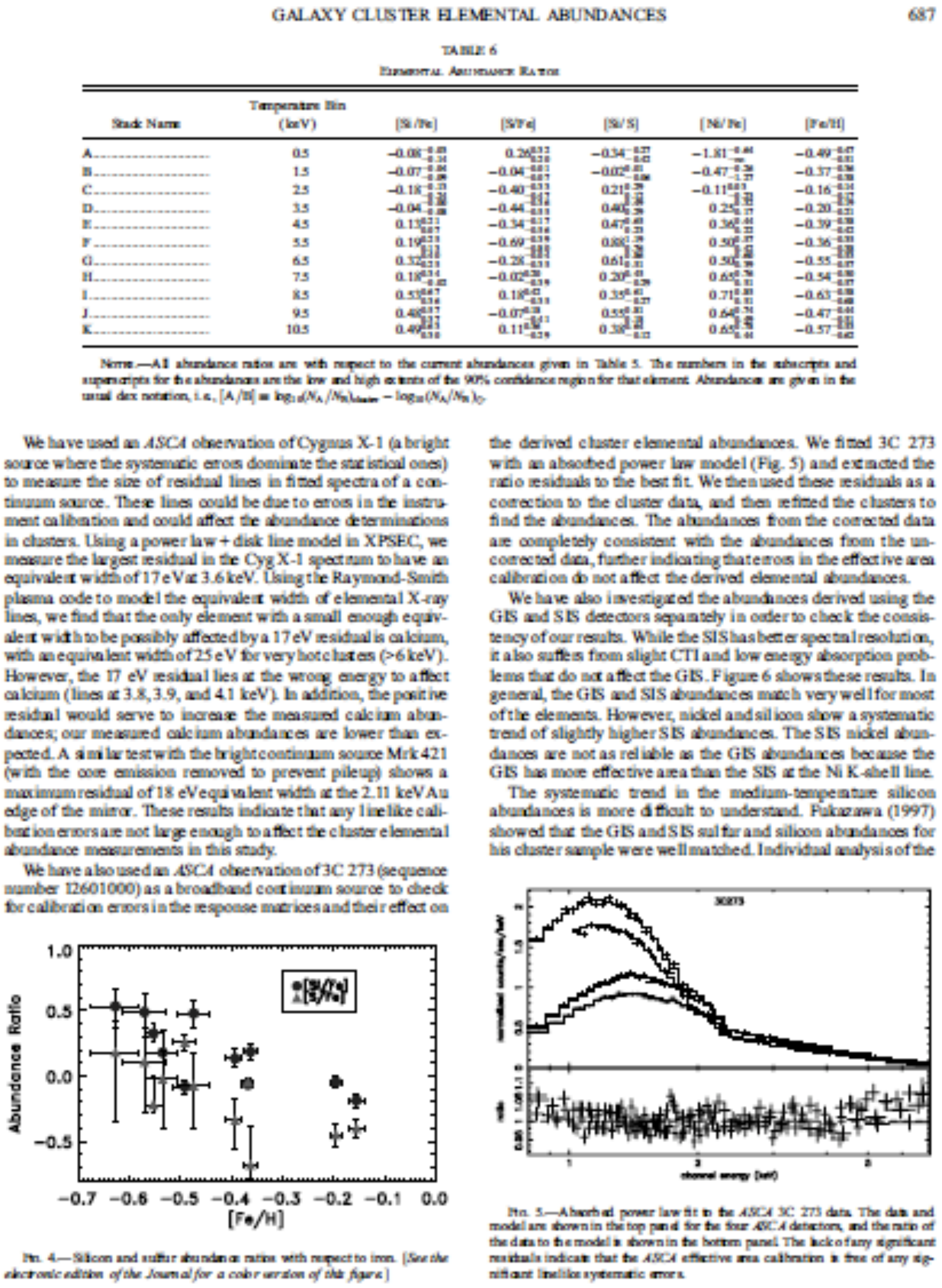

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TABLE 6

Elemental Abundance Ratios

Stack Name	Temperature Bin (keV)	[Si/Fe]	[S/Fe]	[Si/S]	[Ni/Fe]	[Fe/H]
A	0.5	−0.08	0.26	−0.34	−1.81	−0.49
B	1.5	−0.07	−0.04	−0.02	−0.47	−0.37
C	2.5	−0.18	−0.40	0.21	−0.11	−0.16
D	3.5	−0.04	−0.44	0.40	0.25	−0.20
E	4.5	0.13	−0.34	0.47	0.36	−0.39
F	5.5	0.19	−0.69	0.88	0.50	−0.36
G	6.5	0.32	−0.28	0.61	0.50	−0.55
H	7.5	0.18	−0.02	0.20	0.65	−0.54
I	8.5	0.53	0.18	0.35	0.71	−0.63
J	9.5	0.48	−0.07	0.55	0.64	−0.47
K	10.5	0.49	0.11	0.38	0.65	−0.57

Note.—All abundance ratios are with respect to the current abundances given in Table 5. The numbers in the subscripts and superscripts for the abundances are the low and high extents of the 90% confidence region for that element. Abundances are given in the usual dex notation, i.e., $[A/B] \equiv \log_{10}(N_A/N_B)_{\rm cluster} - \log_{10}(N_A/N_B)_\odot$.

We have used an *ASCA* observation of Cygnus X-1 (a bright source where the systematic errors dominate the statistical ones) to measure the size of residual lines in fitted spectra of a continuum source. These lines could be due to errors in the instrument calibration and could affect the abundance determinations in clusters. Using a power law + disk line model in XPSEC, we measure the largest residual in the Cyg X-1 spectrum to have an equivalent width of 17 eV at 3.6 keV. Using the Raymond-Smith plasma code to model the equivalent width of elemental X-ray lines, we find that the only element with a small enough equivalent width to be possibly affected by a 17 eV residual is calcium, with an equivalent width of 25 eV for very hot clusters (>6 keV). However, the 17 eV residual lies at the wrong energy to affect calcium (lines at 3.8, 3.9, and 4.1 keV). In addition, the positive residual would serve to increase the measured calcium abundances; our measured calcium abundances are lower than expected. A similar test with the bright continuum source Mrk 421 (with the core emission removed to prevent pileup) shows a maximum residual of 18 eV equivalent width at the 2.11 keV Au edge of the mirror. These results indicate that any linelike calibration errors are not large enough to affect the cluster elemental abundance measurements in this study.

We have also used an *ASCA* observation of 3C 273 (sequence number 12601000) as a broadband continuum source to check for calibration errors in the response matrices and their effect on the derived cluster elemental abundances. We fitted 3C 273 with an absorbed power law model (Fig. 5) and extracted the ratio residuals to the best fit. We then used these residuals as a correction to the cluster data, and then refitted the clusters to find the abundances. The abundances from the corrected data are completely consistent with the abundances from the uncorrected data, further indicating that errors in the effective area calibration do not affect the derived elemental abundances.

We have also investigated the abundances derived using the GIS and SIS detectors separately in order to check the consistency of our results. While the SIS has better spectral resolution, it also suffers from slight CTI and low energy absorption problems that do not affect the GIS. Figure 6 shows these results. In general, the GIS and SIS abundances match very well for most of the elements. However, nickel and silicon show a systematic trend of slightly higher SIS abundances. The SIS nickel abundances are not as reliable as the GIS abundances because the GIS has more effective area than the SIS at the Ni K-shell line.

The systematic trend in the medium-temperature silicon abundances is more difficult to understand. Fukazawa (1997) showed that the GIS and SIS sulfur and silicon abundances for his cluster sample were well matched. Individual analysis of the

Fig. 4.—Silicon and sulfur abundance ratios with respect to iron. [*See the electronic edition of the Journal for a color version of this figure.*]

Fig. 5.—Absorbed power law fit to the *ASCA* 3C 273 data. The data and model are shown in the top panel for the four *ASCA* detectors, and the ratio of the data to the model is shown in the bottom panel. The lack of any significant residuals indicate that the *ASCA* effective area calibration is free of any significant linelike systematic errors.

A picture is worth a thousand words…
And a table is worth at least 357.3!

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enriched gas from cluster galaxies and gas expelled by the earliest generations of stars and then accreted onto clusters. A combination of X-ray observations well matched to observing metal abundances in clusters and the importance of galaxy clusters as large retainers of Population III–enriched gas make these observations one of the best views onto the earliest generations of stars in the universe.

9. SUMMARY

We have presented intermediate-element abundances for galaxy clusters based on *ASCA* observations. Our measurements of the iron and silicon abundances agree with the past *ASCA* results of Fukazawa (1997) and Mushotzky et al. (1996) but achieve much higher precision and extend the temperature range from 0.5 to 12 keV. The measurements of the individual element abundances show some surprising new results: silicon and sulfur do not track each other as a function of temperature in clusters, and argon and calcium have much lower abundances than expected.

These results show that the α-elements do not behave homogeneously as a single group. The unexpected abundance trends with temperature probably indicate that different enrichment mechanisms are important in clusters with different masses. The wide scatter in α-element abundances at a single temperature could indicate that SN models need some fine-tuning of the individual element yields, or that a different population of SNe needs to be considered as important to metal enrichment in clusters.

We have also attempted to use our measured abundances to constrain the SN types that caused the metal enrichment in clusters. A first attempt to split the metal content into contributions from canonical SNe Ia and SNe II led to inconsistent results with both the individual elemental abundances and with the abundance ratios of our most well-measured elements. An investigation of different SN models also could not lead to a scenario consistent with the measured data, and we deduce that no combination of SNe Ia and SNe II fits the data. Another source of metals is needed.

This extra source of metals must be able to produce enough silicon to match the measurements, but not so much sulfur, argon, or calcium to exceed them. An investigation of SN models in the literature led to three separate models that could fulfill these requirements. All three models were similar and had as progenitor stars massive and/or metal-poor stars. The combination of canonical SNe Ia and SNe II with one of the new models does a much better job of matching the observations. These sorts of massive, metal-poor progenitor stars are exactly the stars that are supposed to make up the very early Population III stars. The conjunction of our required extra source of metals with SNe from Population III–like progenitors supports the idea that a significant amount of metal enrichment was from the very earliest stars.

Clusters are a unique environment for elemental-abundance measurements because they retain all the metals produced in them. The relatively uncomplicated physical environment in clusters also allows well-understood abundance measurements. Future abundance analyses using a large sample of *XMM* data will allow an even better understanding of the SN types and enrichment mechanisms important in galaxy clusters.

The authors would like to thank K. Gendreau for early assistance with this work and K. Kuntz for continued useful conversations and technical advice. The prompt and useful comments of the referee, A. Finoguenov, were also greatly appreciated. This research has made extensive use of data obtained from the High Energy Astrophysics Science Archive Research Center (HEASARC), provided by NASA's Goddard Space Flight Center; the NASA/IPAC Extragalactic Database (NED), which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration; and the SIMBAD database, operated at CDS, Strasbourg, France. The authors extend their sincere thanks to the people responsible for making these resources available online.

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Tell us what was accomplished, what remains to be done in the future, and what it all means!

acknowledgements

Credit where credit is due

LaTeX

LaTeX (http://www.latex-project.org/) is a typesetting (as opposed to a word processing) system where manuscript format and structure are automatically generated.

LaTeX is
- free and easily available
- commonly used for scientific documents
- can easily accommodate mathematical expressions

Many journal articles and conference proceedings, require (or strongly encourage) submitted manuscripts to be created with **LaTeX**, and provide *templates*.

LaTeX

Latex is very powerful for typesetting mathematics.

`The solution to $\sqrt{x} = 5$ is $x=25$.`

produces

The solution to $\sqrt{x} = 5$ is $x = 25$.

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The solution to
\begin{equation}
\sqrt{x} = 5.
\end{equation}
is
\begin{equation}
x=25.
\end{equation}
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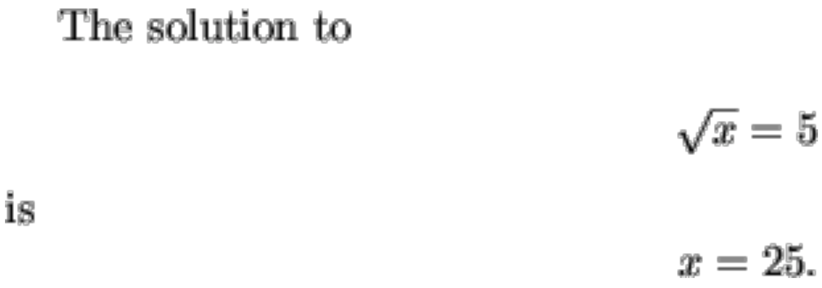
produces



The solution to

$$\sqrt{x} = 5$$

is

$$x = 25.$$

See http://en.wikibooks.org/wiki/LaTeX/Mathematics for list of symbols.

LaTeX

LaTeX is run in comand-line mode as follows:

- latex paper.tex compiles the paper.tex **LaTeX** source file, producing the dvi paper.dvi (*run this twice*).
- dvips paper.dvi –o paper.ps produces a postscript file.
- **ps2pdf** paper.ps paper.pdf converts it into a pdf file.

LaTeX may be learned by experimenting with revisions of pre-existing source files, and referring to manuals (e.g., http://www.giss.nasa.gov/tools/latex/). The homework assignment will give you an opportunity to do this.

A Little More on IDL Basics

- Lines starting with ";" are not executed (used for comments)
- These comments can be "inline."
- help prints the name, type, and value [size] of scalar [array] arguments
- float converts from integer data type
- findgen(N) produces an array [0.0,1.0…float(N-1)]
- fltarr(I,J) creates a floating point array with I columns and J rows; all entries are initialized at 0

http://www.astro.virginia.edu/class/oconnell/astr511/IDLguide.html has useful information and a nice tutorial.

Scalars, Vectors, and Arrays in **IDL**

```
IDL> value=3.3
IDL> array=[1,2,3]
IDL> flarr=float(array)
IDL> help, value, array, flarr
VALUE           FLOAT     =       3.30000
ARRAY           INT       = Array[3]
FLARR           FLOAT     = Array[3]
IDL> print, flarr
     1.00000     2.00000     3.00000
IDL> a=fltarr(3,2)
IDL> print, a
     0.00000     0.00000     0.00000
     0.00000     0.00000     0.00000
IDL> array1=[array,array]
IDL> help, array1
ARRAY1          FLOAT     = Array[6]
IDL> print, array1
     0.00000     1.00000     2.00000     0.00000     1.00000     2.00000
IDL> array2=[[array],[array]]
IDL> help, array2
ARRAY2          FLOAT     = Array[3, 2]
```

```
IDL> print, array2
     0.00000      1.00000      2.00000
     0.00000      1.00000      2.00000
IDL> array2=[[array],[2.0*[array]+1]]
IDL> print, array2
     0.00000      1.00000      2.00000
     1.00000      3.00000      5.00000
IDL> array3=REFORM(array2[1,*])
IDL> help, array3
ARRAY3          FLOAT     = Array[2]
IDL> print, array3
     1.00000      3.00000
IDL> array3=array2[1,*]
IDL> help, array3
ARRAY3          FLOAT     = Array[1, 2]
IDL> print, array3
     1.00000
     3.00000
IDL> array4=REFORM(array3)
IDL> help, array4
ARRAY4          FLOAT     = Array[2]
IDL> print, array4
     1.00000      3.00000
```