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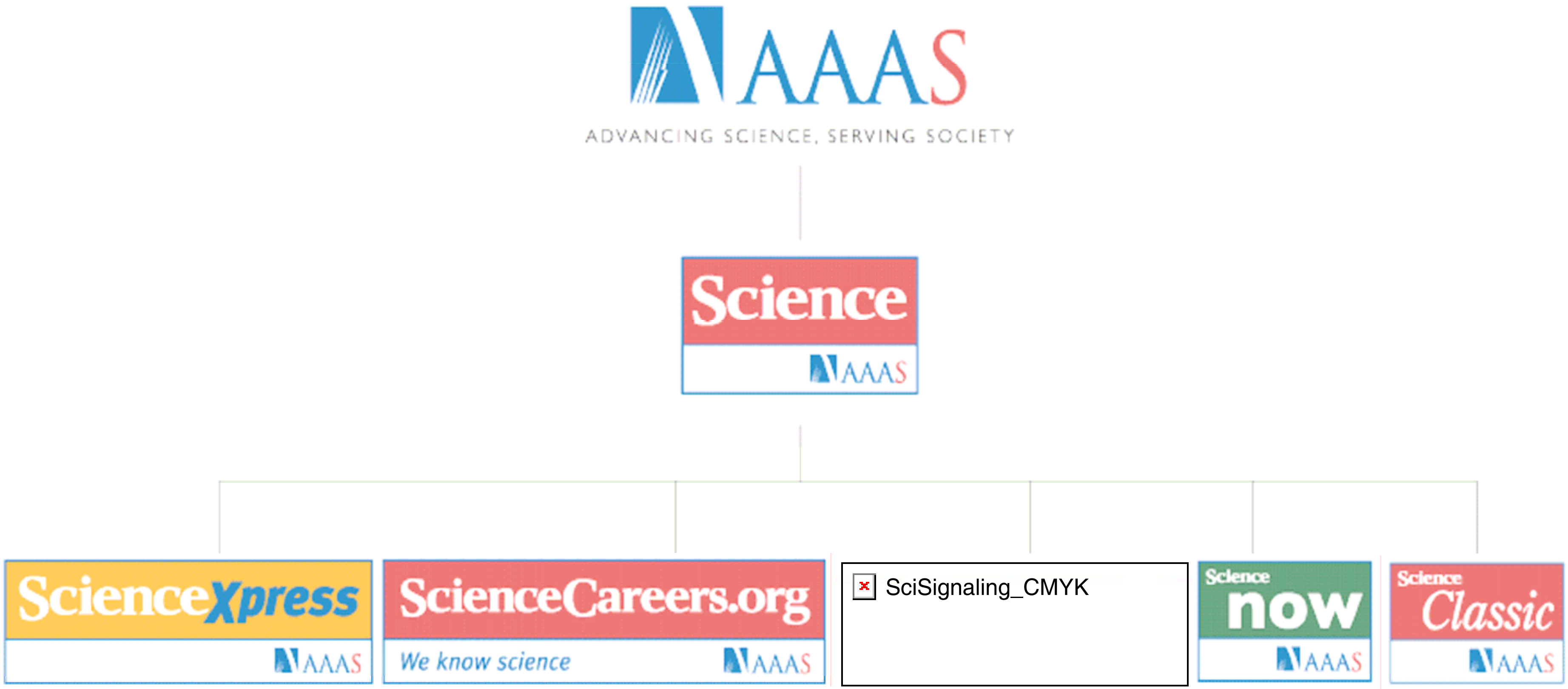

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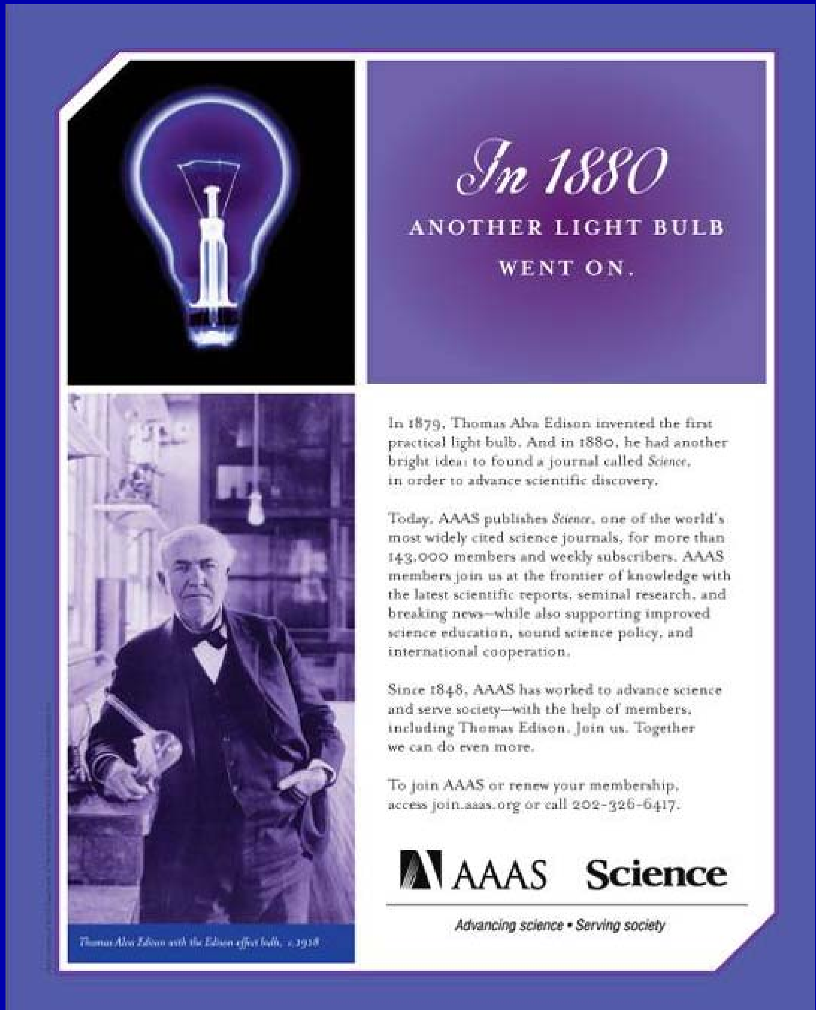

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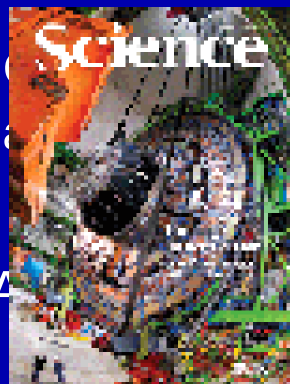

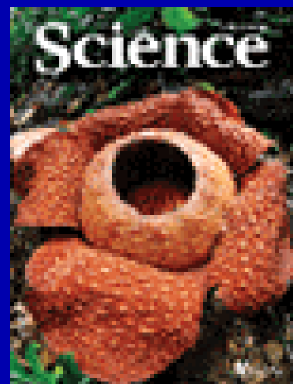

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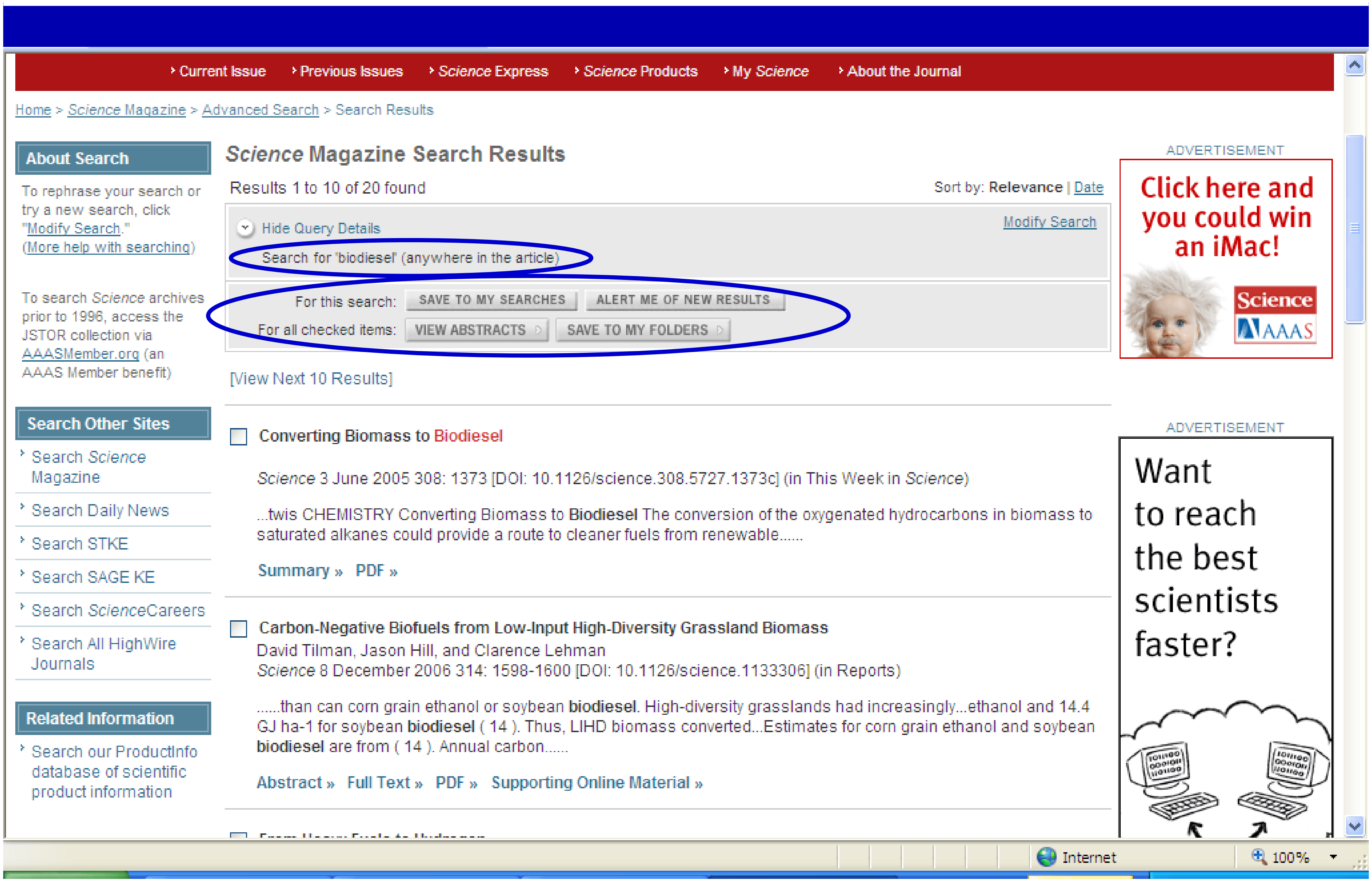

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REPORTS

Renewable Hydrogen from Nonvolatile Fuels by Reactive Flash Volatilization

J. R. Salge, B. J. Dreyer, P. J. Dauenhauer, L. D. Schmidt

Droplets of nonvolatile fuels such as soy oil and glucose-water solutions can be flash evaporated by catalytic partial oxidation to produce hydrogen in high yields with a total time in the reactor of less than 50 milliseconds. Pyrolysis, coupled with catalytic oxidation of the fuels and their fragments upon impact with a hot rhodium-cerium catalyst surface, avoids the formation of deactivating carbon layers on the catalyst. The catalytic reactions of these products generate approximately 1 megawatt of heat per square meter, which maintains the catalyst surface above 800°C at high drop impact rates. At these temperatures, heavy fuels can be catalytically transformed directly into hydrogen, carbon monoxide, and other small molecules in very short contact times without the formation of carbon.

Department of Chemical Engineering and Material Science, University of Minnesota, 421 Washington Avenue SE, Minneapolis, MN 55455, USA.

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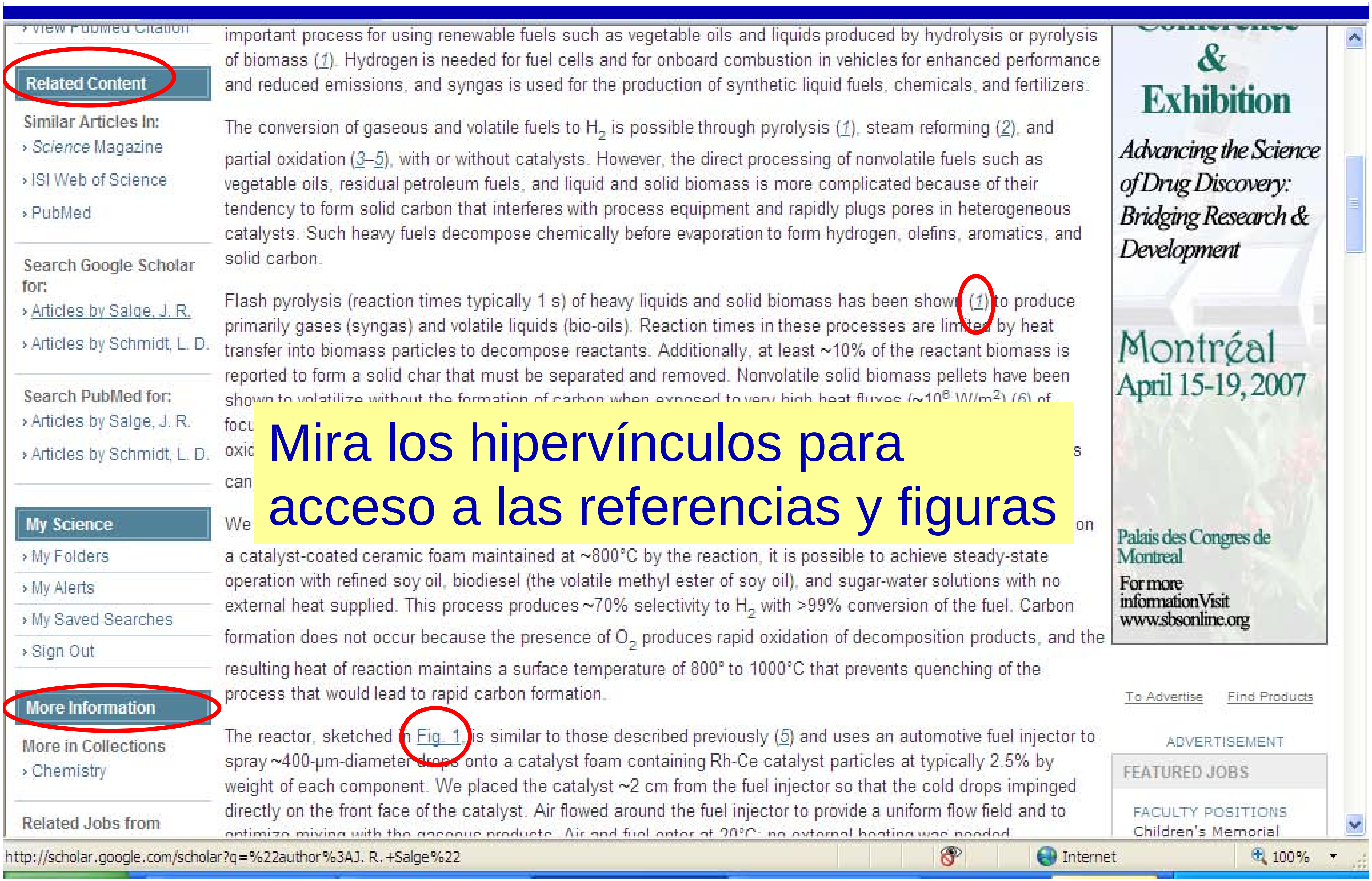

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important process for using renewable fuels such as vegetable oils and liquids produced by hydrolysis or pyrolysis of biomass (1). Hydrogen is needed for fuel cells and for onboard combustion in vehicles for enhanced performance and reduced emissions, and syngas is used for the production of synthetic liquid fuels, chemicals, and fertilizers.

The conversion of gaseous and volatile fuels to H_2 is possible through pyrolysis (1), steam reforming (2), and partial oxidation (3–5), with or without catalysts. However, the direct processing of nonvolatile fuels such as vegetable oils, residual petroleum fuels, and liquid and solid biomass is more complicated because of their tendency to form solid carbon that interferes with process equipment and rapidly plugs pores in heterogeneous catalysts. Such heavy fuels decompose chemically before evaporation to form hydrogen, olefins, aromatics, and solid carbon.

Flash pyrolysis (reaction times typically 1 s) of heavy liquids and solid biomass has been shown (1) to produce primarily gases (syngas) and volatile liquids (bio-oils). Reaction times in these processes are limited by heat transfer into biomass particles to decompose reactants. Additionally, at least ~10% of the reactant biomass is reported to form a solid char that must be separated and removed. Nonvolatile solid biomass pellets have been shown to volatilize without the formation of carbon when exposed to very high heat fluxes (~10^6 W/m^2) (6) of

a catalyst-coated ceramic foam maintained at ~800°C by the reaction, it is possible to achieve steady-state operation with refined soy oil, biodiesel (the volatile methyl ester of soy oil), and sugar-water solutions with no external heat supplied. This process produces ~70% selectivity to H_2 with >99% conversion of the fuel. Carbon formation does not occur because the presence of O_2 produces rapid oxidation of decomposition products, and the resulting heat of reaction maintains a surface temperature of 800° to 1000°C that prevents quenching of the process that would lead to rapid carbon formation.

The reactor, sketched in Fig. 1, is similar to those described previously (5) and uses an automotive fuel injector to spray ~400-µm-diameter drops onto a catalyst foam containing Rh-Ce catalyst particles at typically 2.5% by weight of each component. We placed the catalyst ~2 cm from the fuel injector so that the cold drops impinged directly on the front face of the catalyst. Air flowed around the fuel injector to provide a uniform flow field and to optimize mixing with the gaseous products. Air and fuel enter at 20°C; no external heating was needed.

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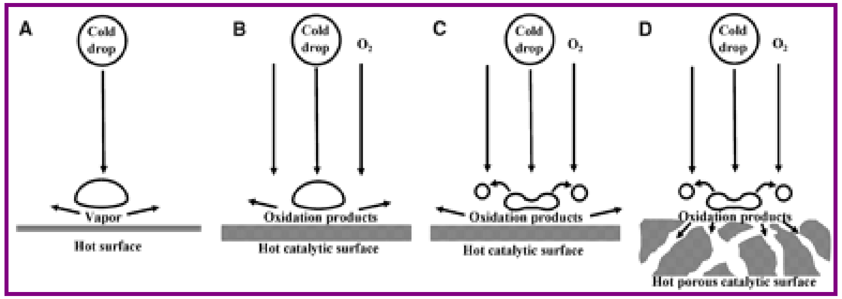

Fig. 3. Sketches of possible configurations of (**A**) conventional film boiling of a volatile drop on a hot surface, (**B**) reactive drop volatilization on a hot catalyst surface, (**C**) dropimpingement and breakup on a hot catalytic surface, and (**D**) drop impingement and breakup on a hot catalytic porous surface. [View Larger Version of this Image (71K JPEG file)]

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experiments, long-term evaluation, and modeling to optimize catalyst performance and determine the exact mechanisms of reactive flash volatilization.

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14. Our system processes approximately 0.6 kg/day of fuel diameter would process ~5.2 kg/day under identical co fuel injectors to obtain sufficiently low flows, but larger injectors, or different methods for uniform drop formatio
15. This research was supported by grants from the U.S. De Initiative for Renewable Energy and the Environment at

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Cited References: 18 **Times Cited:** 11

Abstract: The image furnace technology has been applied to the study of the first steps of biomass flash pyrolysis. The experiments performed with small pellets of cellulose show that the reaction primarily passes through the intermediate of short lifetime liquid species (ILC). The quantitative study of the variations of the sample mass loss and of the mass of ILC reveals the existence of a transient period followed by a steady-state regime resulting from an equilibrium between cellulose decomposition into ILC and ILC vaporization. A mathematical model has been solved in parallel. The results agree very well with the experimental measurements and yield additional information on the temperatures of cellulose pyrolysis and of ILC vaporization. (C) 2002 Elsevier Science Ltd. All rights reserved.

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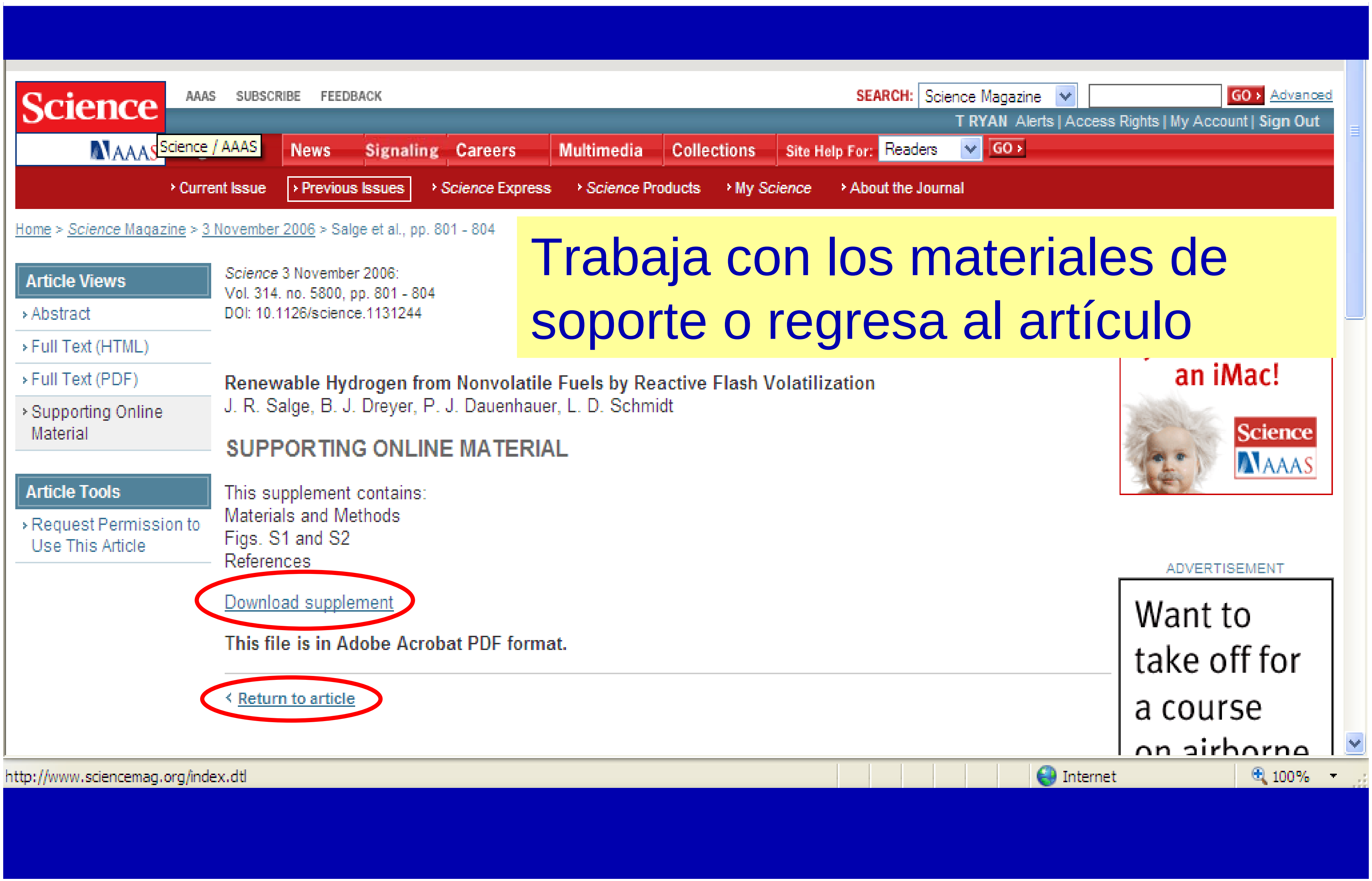

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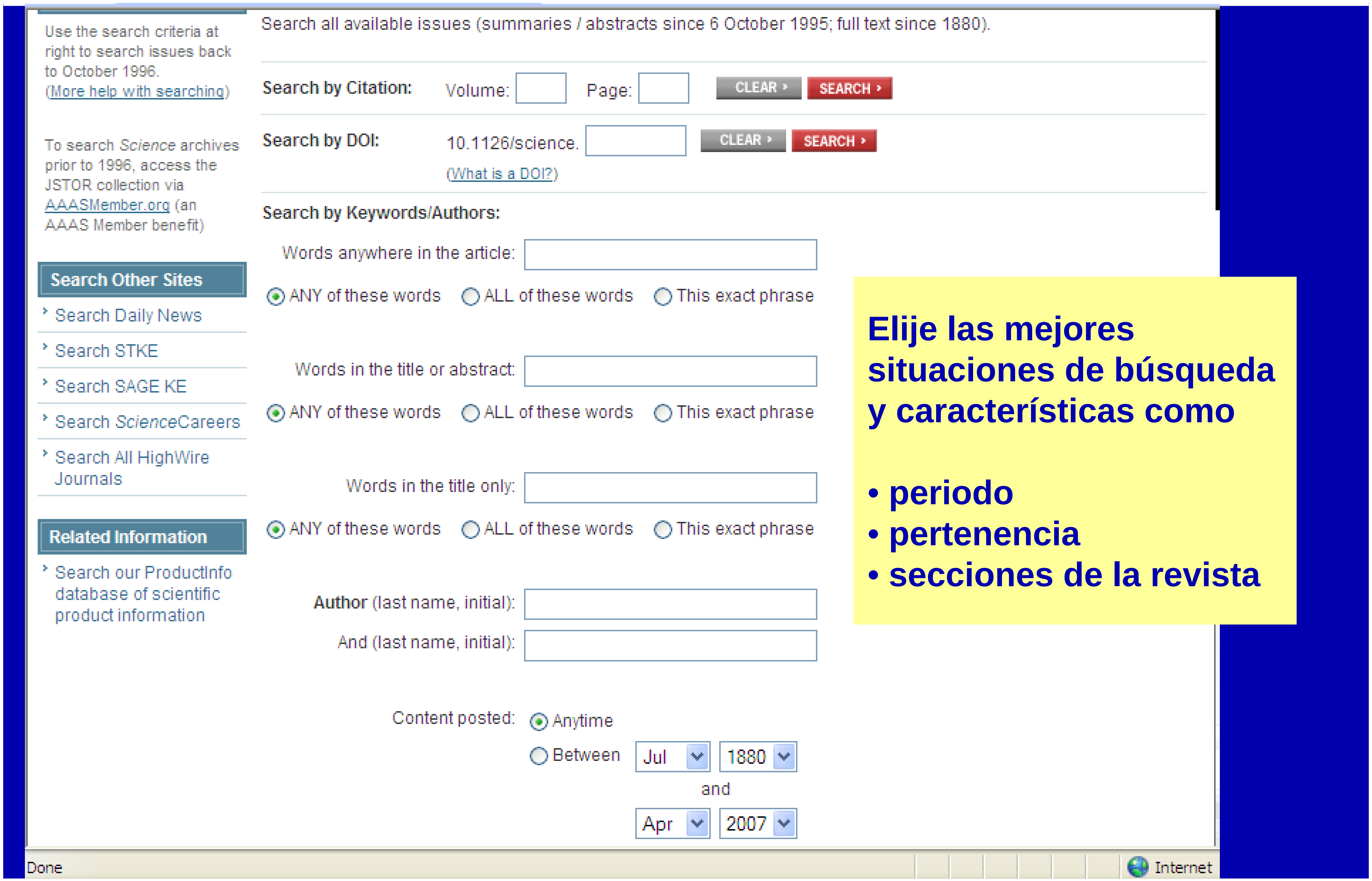

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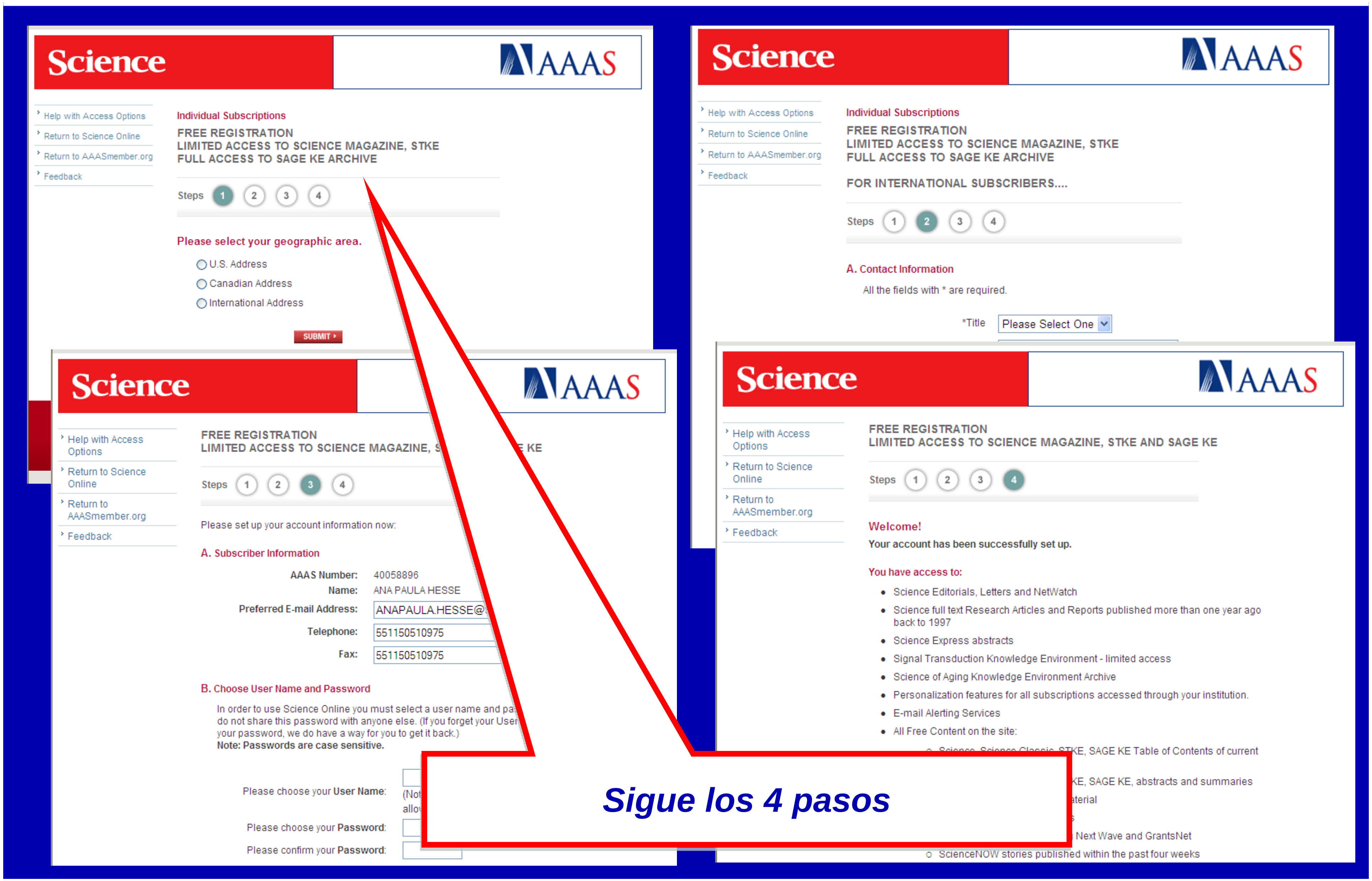

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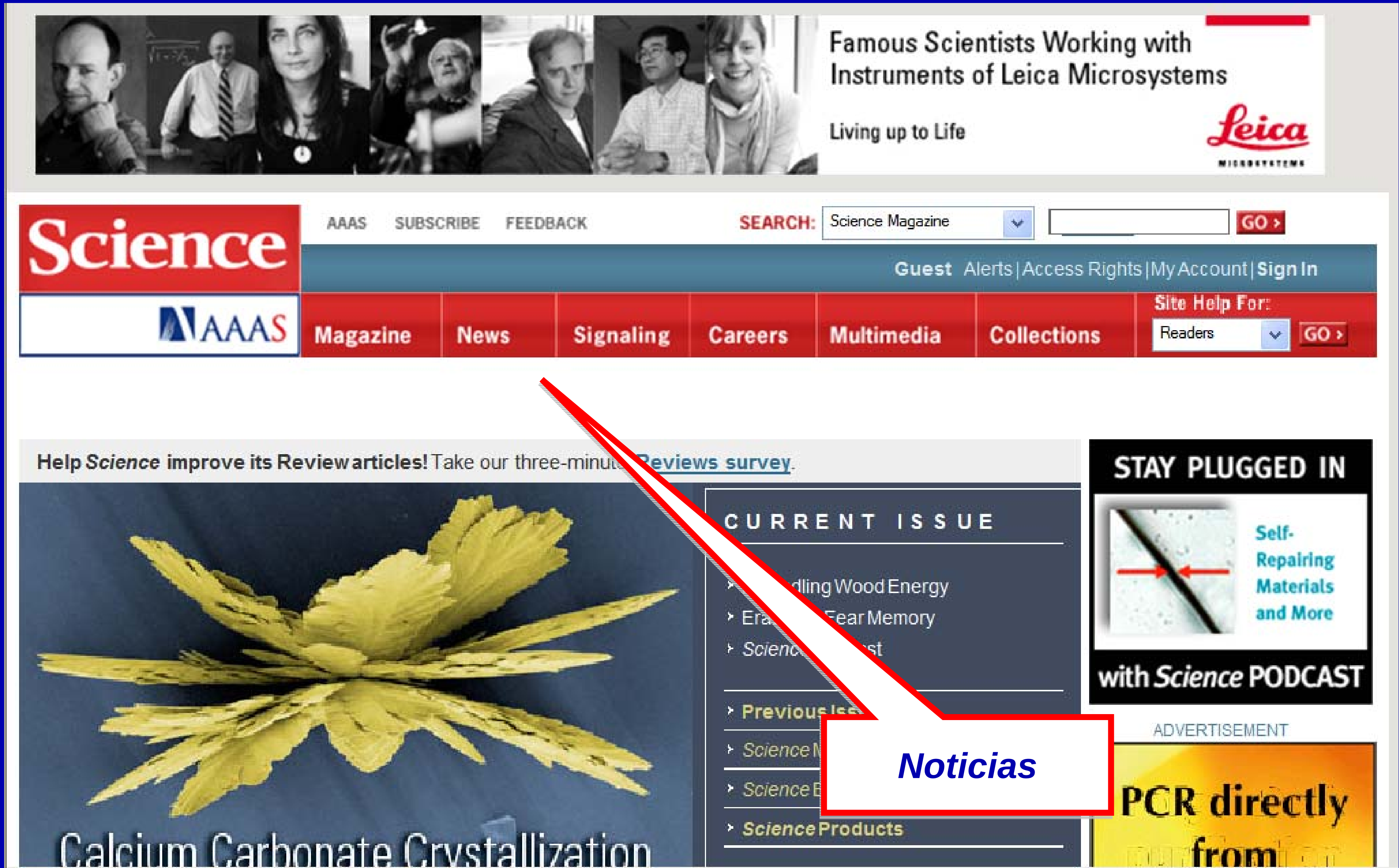

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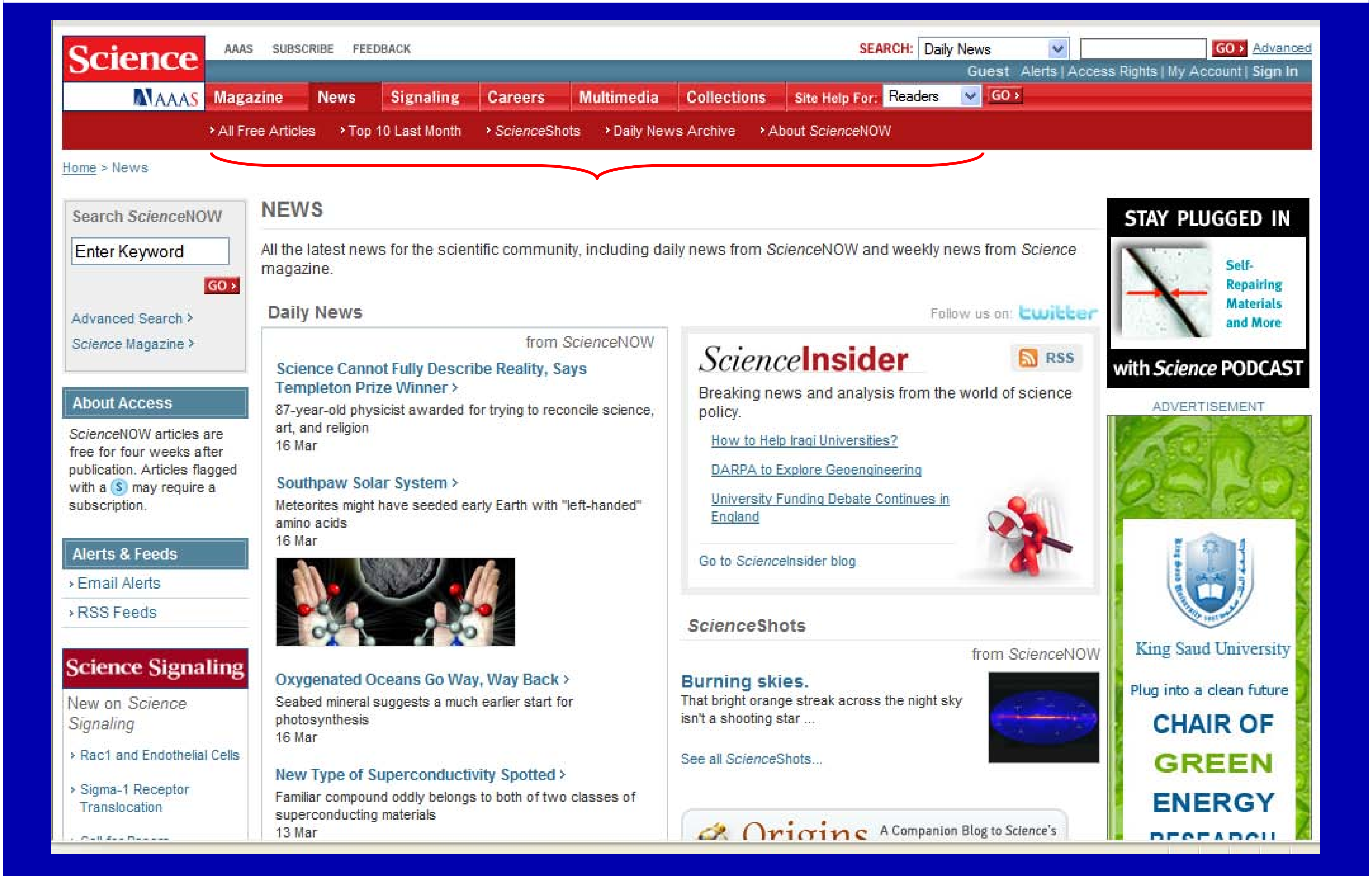

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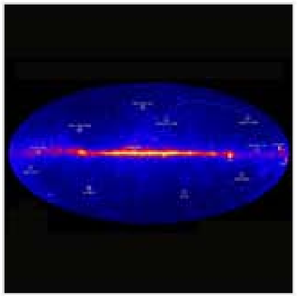
Tiny predator. Researchers have discovered the smallest non-avian dinosaur known to North America. Named *Hesperonychus elizabethae*, the 75-million-year-old carnivore was about half the size of a house cat and came equipped with razor-sharp claws, one of which was shaped like a sickle (*Hesperonychus* means "western claw"). The creature prowled the swamps and forests of western Canada on its two legs in search of insects, small mammals, and the hatchlings of other dinosaurs, scientists report today in the *Proceedings of the National Academy of Sciences*. Researchers were initially duped by *Hesperonychus*'s small claws, which made the animal look like a juvenile, but fused hip bones--an indication of adulthood--confirmed its full-grown size. Until now, the smallest North American non-avian dinosaur was believed to be about the size of a wolf. *(Image: ©2009 Nick Longrich)*



Burning skies. That bright orange streak across the night sky isn't a shooting star. It and the other orange dots in this picture--an image of the universe compiled from 3 months of observations by the Large Area Telescope aboard NASA's Fermi spacecraft--are gamma rays, the most intense energy form known. Some 150-million times more intense than visible light, gamma-rays result from only extreme cosmic events, such as flares from supermassive black holes, the creation of pulsars (the burned-out remnants of collapsed giant stars), or pairs of giant stars or black holes tugging at each other in tight orbits. Generally, gamma-ray bursts are short-lived phenomena, but as this image shows, they're also relatively common, both within and outside the Milky Way galaxy. *(Image: NASA/DoE/Fermi LAT Collaboration)*

Thar she blows! How do you assess a whale's sex drive? There's no easy way to take a blood sample, so scientists have resorted to finding feces--a tricky task itself, especially in the Southern Ocean, where conditions make spotting whale poop all but impossible. Enter blowholes: All whales have to

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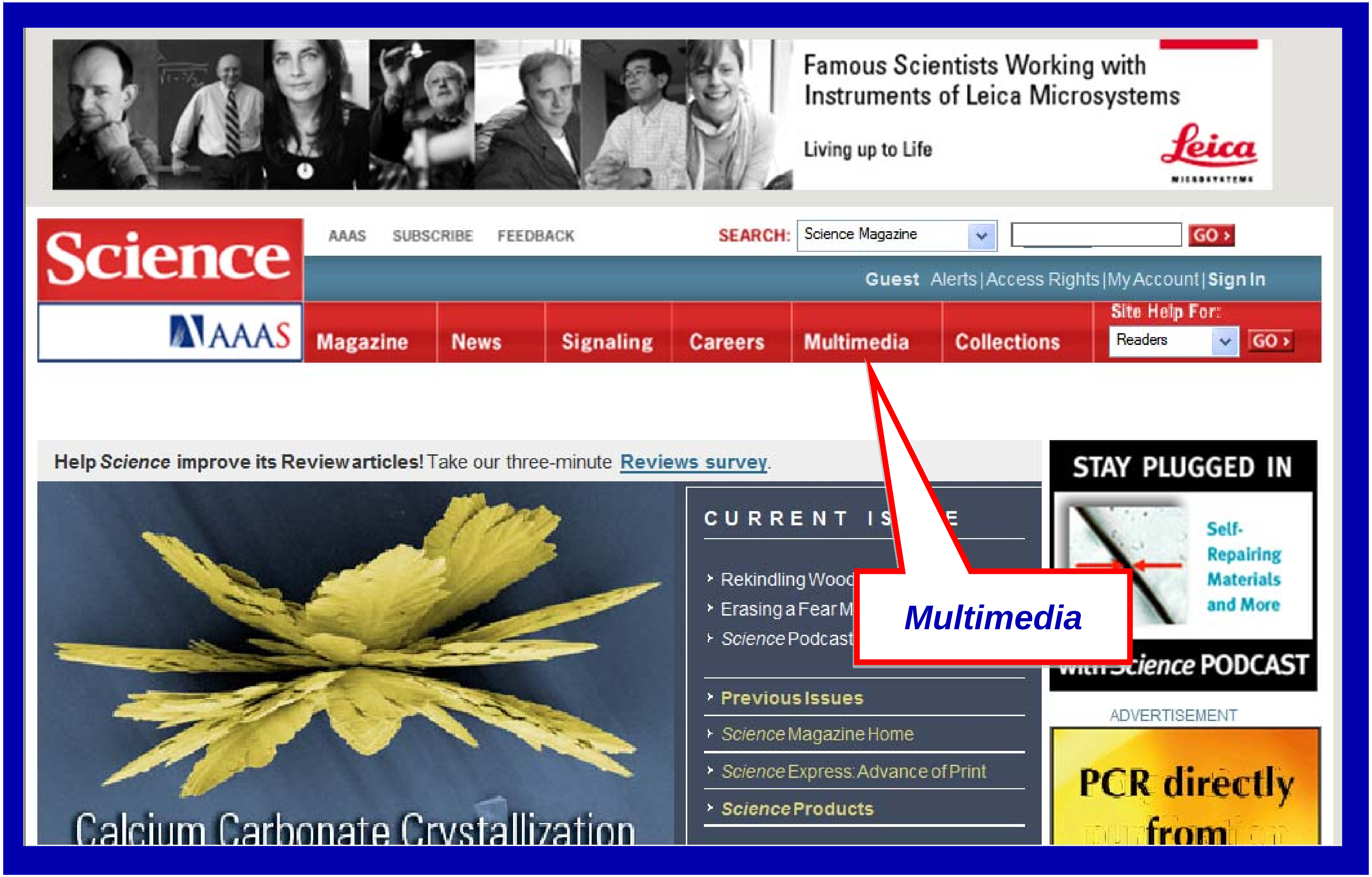

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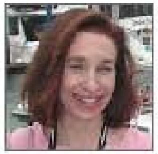

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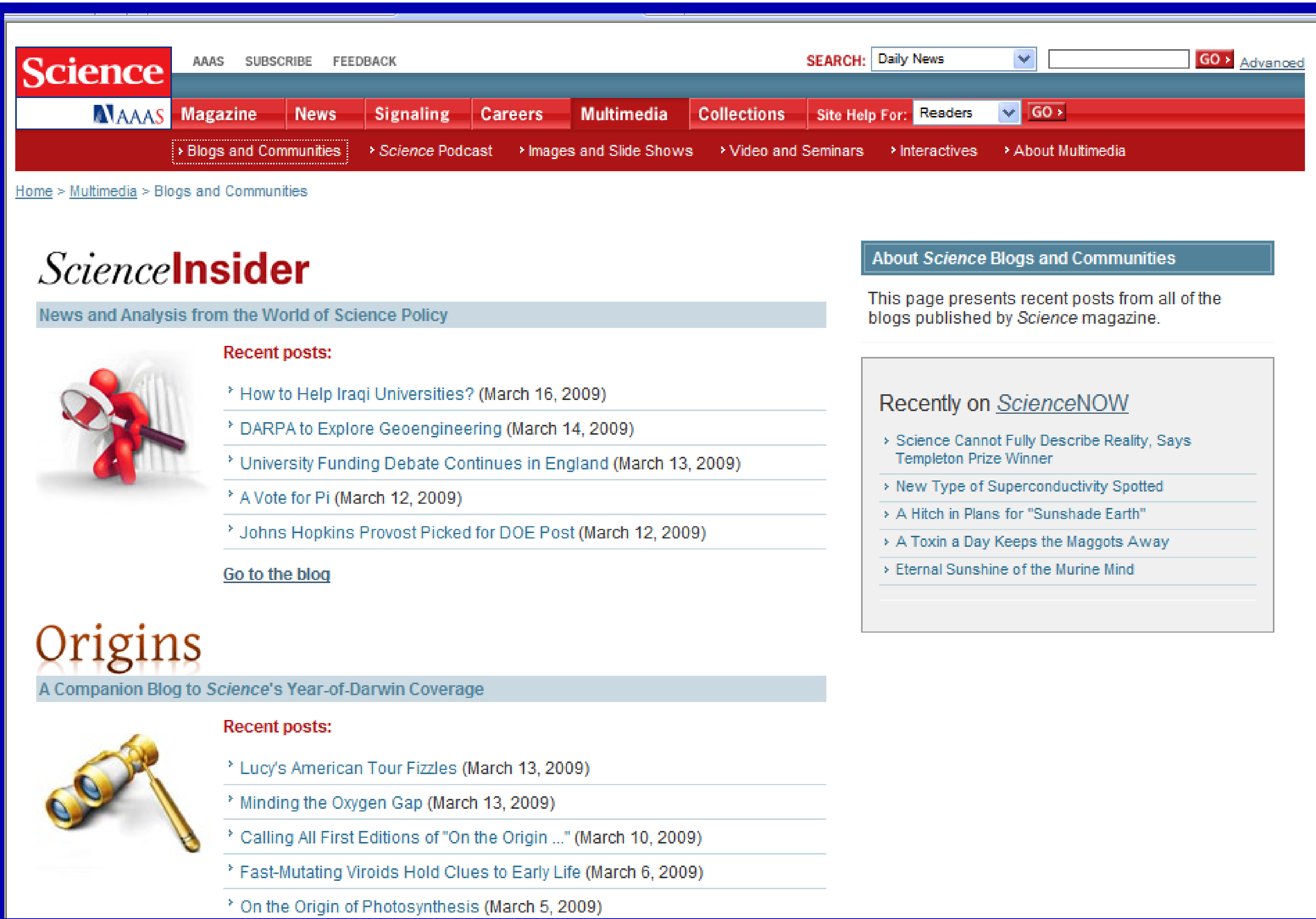

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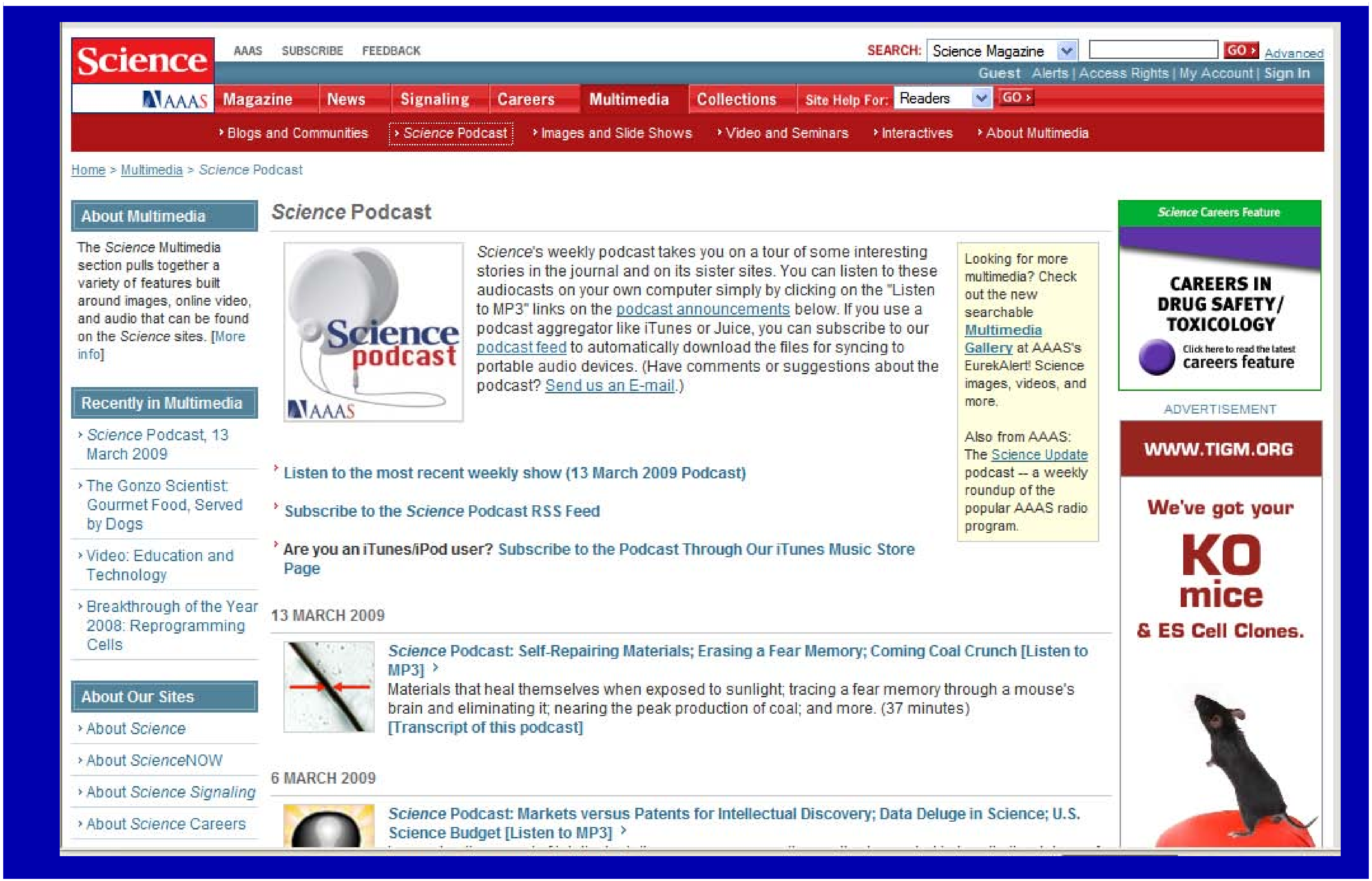

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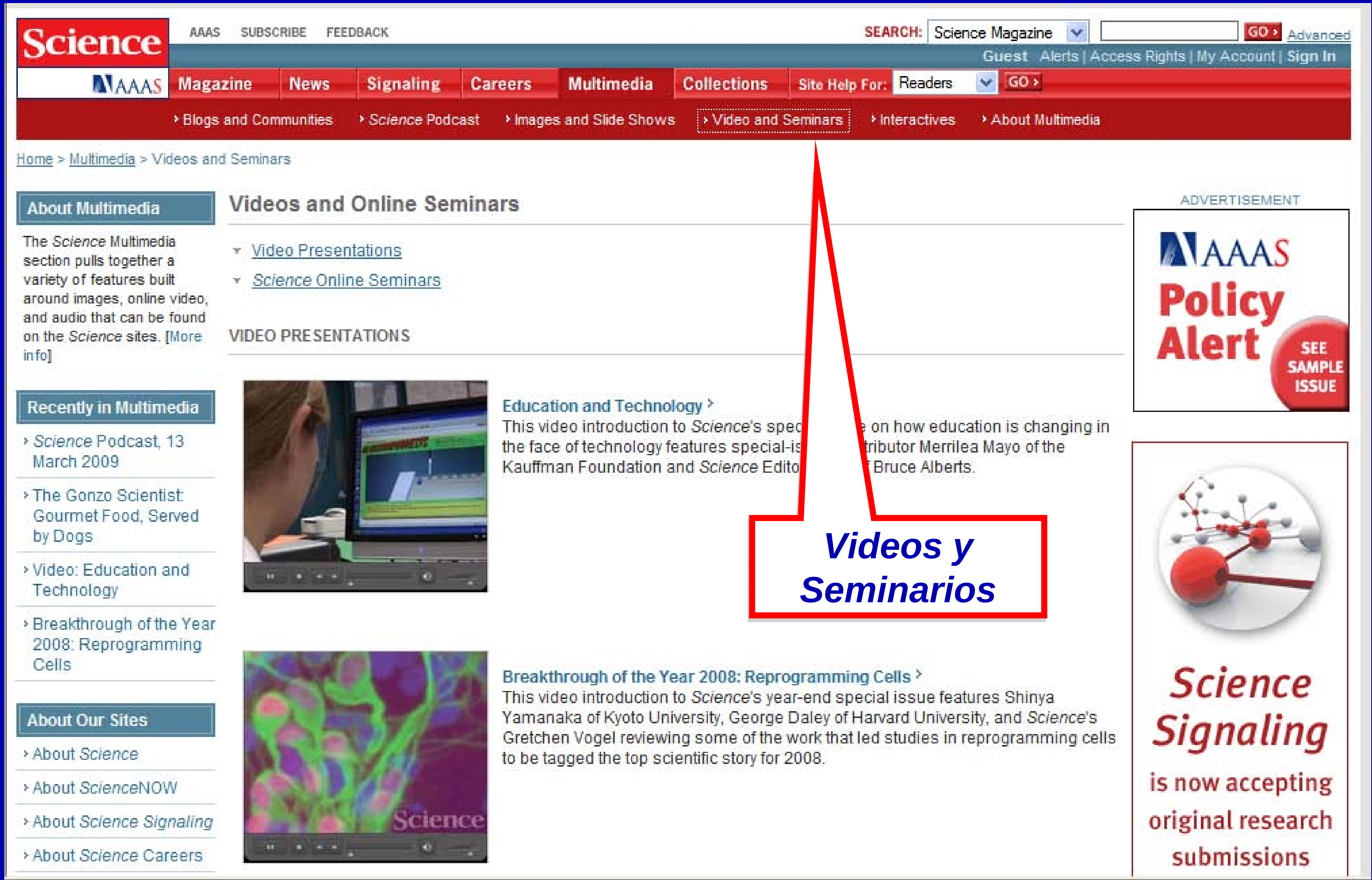

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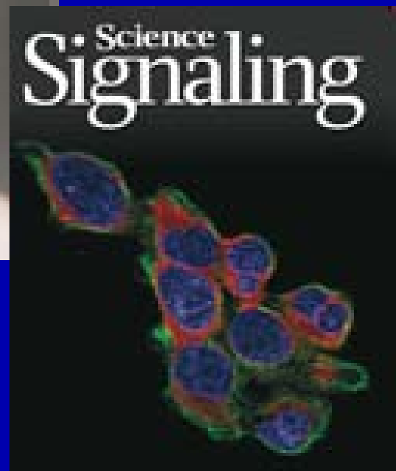

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In Community

E-Letters
Featured E-Letter: Breaking T cell activation by IKKβ. Did you modify or adapt a method described in an STKE Protocol? Did you use an STKE Teaching Resource? Did an article featured in Editors' Choice remind you of a related study? Share your insight, experience, and tips with other readers. Find out how to submit a comment to make STKE a rich community by contributing your knowledge.

Directory
Featured person: Nathan Bowen. Find collaborators and people with shared research interests - join the Signaling community and add your information to the Directory!

Forums
Join the ongoing discussion in the Open Discussion of Modeling and Computational Approaches to Cellular Signaling forum.

SIGNALING: otras características

Career Tools:

- Find a Job
- Find a Grant
- Find a Meeting/Event

New Articles on Careers

- Immigration and Postdoc Pay
- Writing PhD Papers That Shine
- More Careers Articles

In Resources

Teaching Resources
More than 50 different resources provide information for course planning, lecture notes, slides, and animations.

Glossary
Find out what those acronyms and abbreviations mean. Browse or search the glossary of cell signaling terms. Look at the list of the most recently added terms.

Events
Featured event: BPS Focused Meeting on Cell Signalling. Submit a meeting or conference with sessions on cell signaling or view the current calendar.

ST NetWatch
Featured in Bioinformatics Resources: Cancer Genome Anatomy Project (CGAP). Explore the sites selected by the editors or submit your favorite signal transduction Web site.

Jobs
Search or browse employment opportunities related to signal transduction in *Science* careers.

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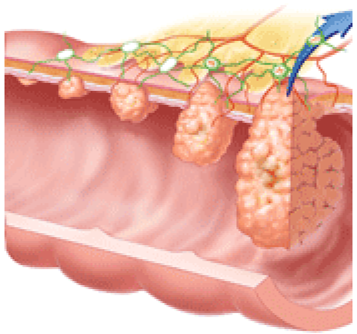
In the Current Issue

10 April 2007 (Issue 381)



Cancer progression

- Image details
- Current Issue Table of Contents

New in the Database of Cell Signaling

Featured Connections Map: Epidermal Growth Factor Receptor Pathway

Browse all Pathways »

Editors' Choice

Sensing Salt, Sending Signals

H. Shimizu *et al.*, *Neuron* **54**, 59-72 (200

C. Iadecola *et al.*, *Neuron* **54**, 3-5 (2007).

Summary

plus...

- Full List of This Week's Summaries
- Featured in *Science* Magazine

Editorial Guide

Focus Issue: Exploring Ne... es for Cancer Treatment

Elizabeth M. Adler and N... Gough

Abstract | Full Text |

Perspectiv...

Meeting ...ort: Tumor Biology--How Signaling Processes Translate to Therapy

Karl... Friedrich, Ottmar Janssen, and Ralf Hass

Ab...act | Full Text | PDF

Metabolic Targeting as an Anticancer Strategy: Dawn of a New Era?

James G. Pan and Tak W. Mak

Abstract | Full Text | PDF

Review

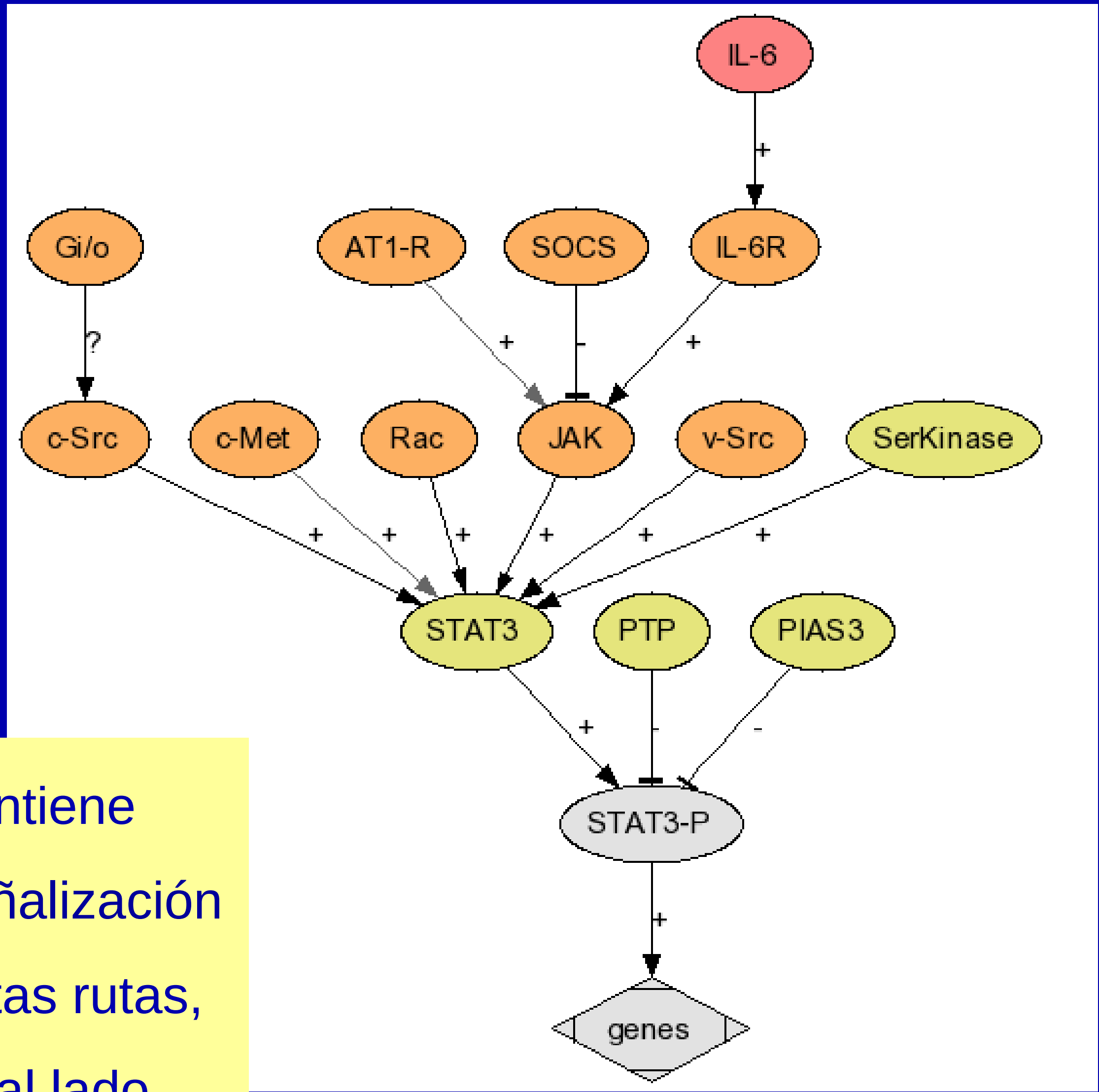
Sequestration and Segregation of Receptor Kinases in Epithelial Cells: Implications for ErbB2 Oncogenesis

Coralie A. Carothers Carraway and Kermit L. Carraway

Gloss | Abstract | Full Text | PDF

Mapas de Conexión: base de datos de señalización celular

Mapas de Conexión: base de datos de sinalización celular



Esta base de datos contiene informaciones de rutas de señalización celular y la relación entre estas rutas, mostrado en la interfaz de al lado.

Mapas de Conexión: base de datos de sinalización celular

Connections Maps & Data

- Canonical Pathways
- Specific Pathways
- Canonical Components
- Specific Components

More Information

- Pathway Authorities
- Terms, Software Tips & Data Attributes
- Commercial Products
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- Terms of Use

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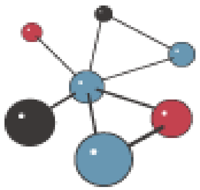

This database provides information on the components of cellular signaling pathways and their relations to one another, which are organized into pathways called Connections Maps, which serve as the graphical interface into the database. Scientists with expertise in a given field, designated as Pathway Authorities, provide the information. With canonical or general data about cell signaling, as well as specific data about particular signaling processes in specific organisms and cells, there is information for both novices to cell signaling and experts. More about Connections Maps ›

Browse Connections Maps Pathways

Expandable lists of pathways

- By Subject
- By Scope
- By Model Organism
- By *Science* Issue

Browse Connections Maps Components

Information about molecules in the database

- By Alphabetical List
- By Model Organism
- By Type

Contacto

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