

Deploying InvenioRDM as an institutional repository platform for data, software, and publications

Tom Morrell

Coalition for Networked Information (CNI) Spring Meeting

April 4, 2023

<https://doi.org/10.5281/zenodo.7799359>

Caltech

- Big impact – 46 Nobel prizes
- Manages the Jet Propulsion Laboratory (JPL), Palomar and W. M. Keck Observatories, and co-manages LIGO
- Small - 300 faculty, 1,000 undergraduates, 1,400 graduate students
- Library has run institutional repositories since 2001; over 100,000 items



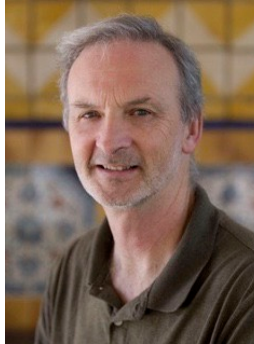
Robert Doiel



Tommy Keswick



Mike Hucka



Stephen Davison



Kathy Johnson



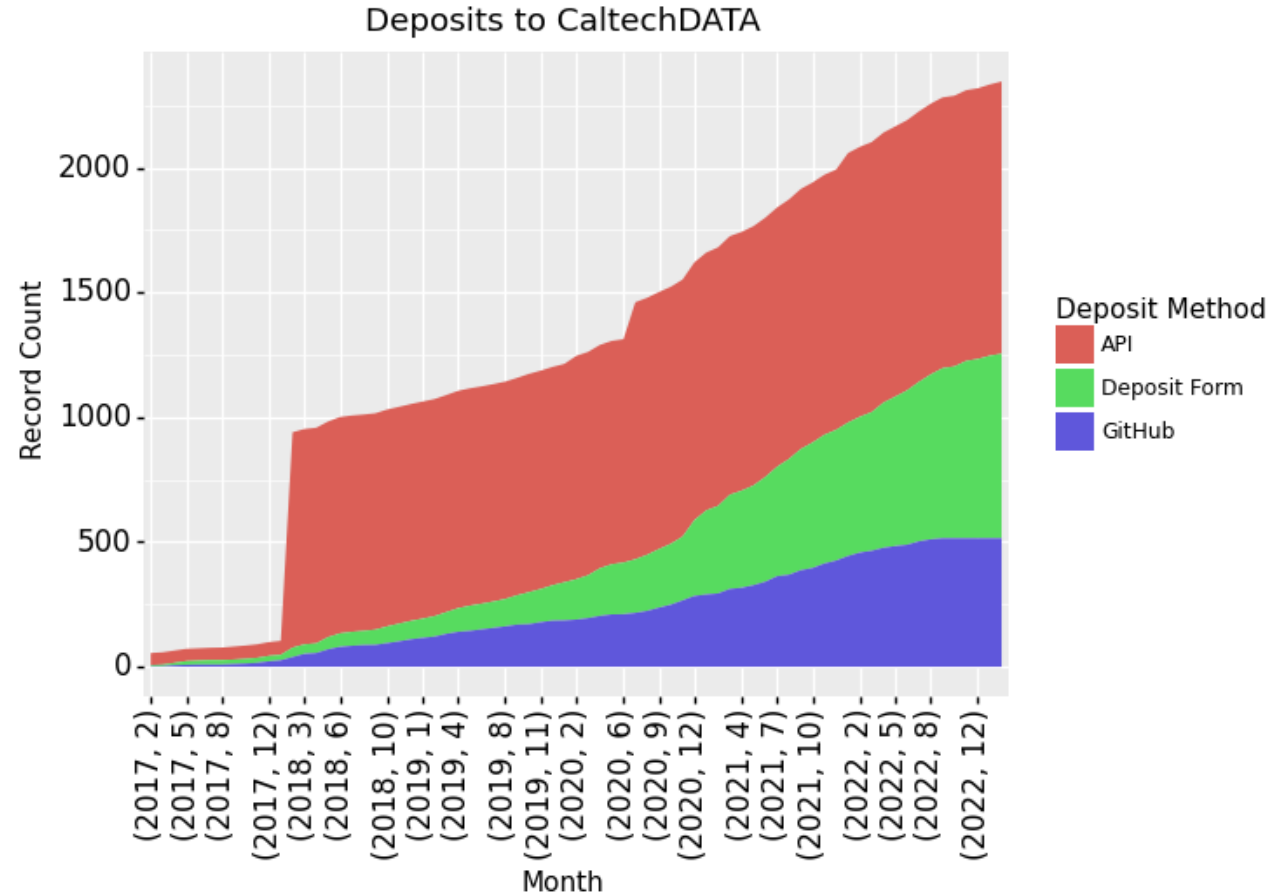
George Porter



Tony Diaz

CaltechDATA

- Institutional repository for Caltech researchers (<https://data.caltech.edu>)
- Started in 2017
- Grown to over 26,000 records; over 10 TB of storage
- Submissions from over 6% of campus



Note: Excludes ~23,000 API-migrated records from MEAD

What's in CaltechDATA?

Table 1. Compilation of dip angles and subduction parameters along the 153 transects.

Index [lat lon]	Trench	φ_{azi} (°)	V_{conv} (cm/yr)	V_{up} (cm/yr)	V_{sub} (cm/yr)	T_{cons} (km)	A_{slab} (Ma)	A_{re} (Ma)	A_{long} (Ma)	OPN	D_{Moho} (km)
1 [60.09 -145.46]	AL	323.36	4.85	-0.11	4.75	2441.60	42.49 153-120		230 c		40.90
2 [58.59 -149.20]	AL	320.16	5.12	-0.13	4.99	2544.49	45.70 153-120		230 c		45.27
3 [56.98 -152.45]	AL	315.32	5.34	-0.23	5.12	2640.72	48.47 153-120		230 c		34.47
4 [55.44 -155.22]	AL	314.56	5.60	-0.19	5.41	2726.20	49.82 153-120		230 c		32.06
5 [54.31 -158.11]	AL	326.59	5.88	0.31	6.20	2805.70	51.45 153-120		230 c		32.35
6 [53.33 -161.60]	AL	337.29	5.85	0.77	6.62	2891.46	53.01 153-120		230 c		30.37
7 [52.47 -165.32]	AL	340.66	5.84	0.95	6.79	2975.09	54.83 153-120		230 c		28.68
8 [51.64 -168.96]	ALU	343.50	5.78	1.11	6.89	3052.13	57.64	69 NA	c		23.60
9 [50.90 -172.64]	ALU	340.64	5.98	1.08	7.06	3123.34	59.86	69 NA	c		23.71
10 [50.60 -176.38]	ALU	352.91	5.18	1.47	6.64	3181.51	53.98	69 NA	c		20.94
11 [50.46 -179.93]	ALU	6.93	3.83	1.78	5.61	3231.32	52.14	69 NA	c		22.16
12 [50.85 -176.23]	ALU	10.74	3.30	1.84	5.14	3266.61	49.08	69 NA	c		17.41
13 [51.82 -172.64]	ALU	25.23	1.47	1.92	3.40	3286.43	42.66	69 NA	c		18.16
14 [9.23 -85.37]	MAM	39.04	8.47	-0.63	7.84	1843.77	18.69 75-73	NA	c		39.25
15 [15.17 -96.80]	MEX	9.77	6.04	0.13	6.17	2566.01	16.48 NA		220 c		39.53
16 [7.85 -83.60]	MAM	37.13	8.93	-0.80	8.13	1822.99	14.74 75-73	NA	c		29.59
17 [10.90 -87.39]	MAM	27.60	8.14	-0.57	7.57	1864.96	61.93 75-73	NA	c		33.69
18 [15.8 -98.8]	MEX	22.50	6.16	0.70	6.87	2501.70	9.67 NA		220 c		40.20
19 [11.85 -89.30]	MAM	27.82	7.74	-0.43	7.31	1881.52	23.27 75-73	NA	c		39.65
20 [16.6 -100.7]	MEX	21.24	5.59	0.67	6.26	2431.92	7.67 NA		220 c		40.57
21 [12.67 -90.96]	MAM	32.29	7.35	-0.27	7.08	1893.90	24.86 75-73	NA	c		41.55
22 [17.6 -102.9]	MEX	27.54	5.10	0.92	6.03	2347.35	4.91 NA		220 c		36.43
23 [13.70 -92.91]	MAM	26.87	6.95	-0.17	6.78	1906.25	25.42 75-73	NA	c		35.04
24 [18.50 -104.40]	MEX	46.60	4.65	1.34	5.98	570.27	7.65 NA		220 c		35.15

Hu, Jiashun and Gurnis, Michael; Supplementary Data for manuscript entitled "Subduction Duration and Slab Dip" <https://10.22002/D1.1380>



Iwashita, Yumi et al.; JPL Mars Yard Database <https://10.22002/D1.1332>



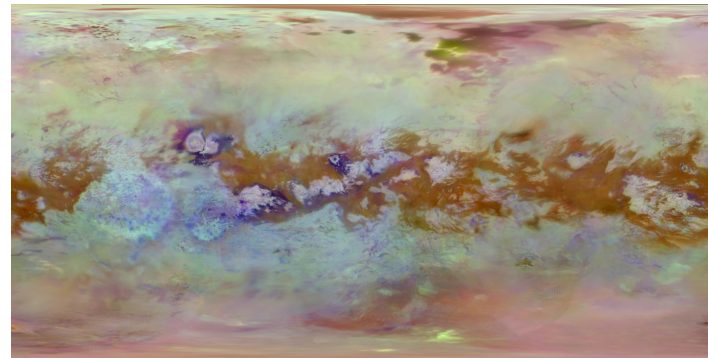
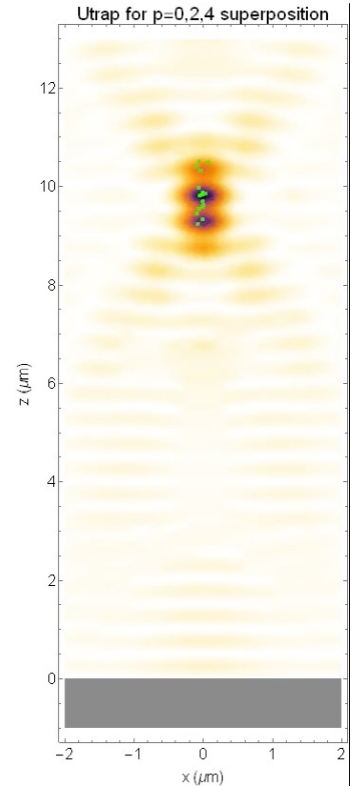
Witkosky, Rebecca; Mako thermal infrared hyperspectral airborne emissivity image, field photographs, and ground-based spectra of the San Andreas fault and Thousand Palms Oasis in the Coachella Valley, California <https://10.22002/D1.1236>

```
# csv file with metadata information for each dataset
# must have the species information, subsampling levels for reads, total reads,
# technology used and path to one fastq file for R1 and one for R2
# if you have multiple files for each read they must be concatenated first
metadatas=pd.read_csv('./cell-depth-tradeoff-metadata.tsv', sep='\t')

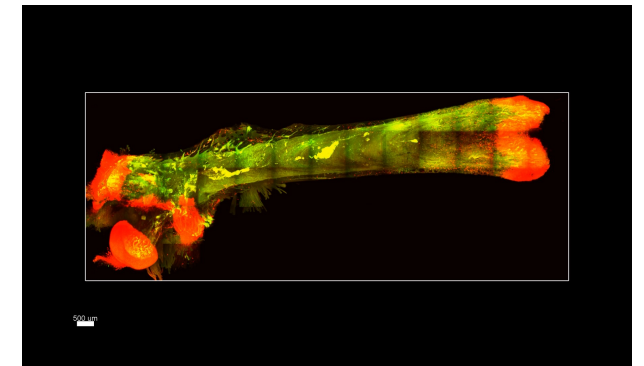
def make_t2g_path(wildcards):
    DATASET_SAMPLE_ID = wildcards.dataset_sample_id
    species = metadatas[metadatas['dataset_sample_id']==DATASET_SAMPLE_ID]['species'].values[0]
    if species=='mouse':
        T2G = os.path.join(REF_PATH, 'mus_musculus-ensembl-96/transcripts_to_genes.txt')
    if species=='human':
        T2G = os.path.join(REF_PATH, 'homo_sapiens-ensembl-96/transcripts_to_genes.txt')
    return T2G
```

Valentine Svensson, Eduardo da Veiga Beltrame, and Lior Pachter. Code for producing the analysis in the "Quantifying the tradeoff between sequencing depth and cell number in single-cell RNA-seq" <https://10.22002/D1.1276>

J.-B. Béguin et al. Reduced volume and reflection for optical tweezers with radial Laguerre-Gauss beams <https://10.22002/D1.1346>



Seignovert, Benoît et al. Titan's global map combining VIMS and ISS mosaics <https://10.22002/D1.1173>



Chan, Ken, Greenbaum, Alon, Gradinaru, Viviana; Visualizing endogenous fluorescence throughout a cleared mouse femur <https://10.22002/D1.1234>

Repository details

- The initial version of CaltechDATA was inspired by Zenodo
 - Easy to describe and upload files
 - Researchers control their records
 - All records get a DOI
 - Integration with GitHub
 - API for accessing data
- Lots of other institutions had the same idea



InvenioRDM Partners



Introducing InvenioRDM

- InvenioRDM is build on the Invenio repository platform (Python!)
- Inspired by Zenodo, but customizable by institutions
- Designed around data and software, but supports all item types
- CaltechDATA was an early migration; Zenodo itself is migrating this fall



Built-in features

- User-friendly deposit form
 - Auto-complete
 - Creators and contributors with ORCIDS
 - Affiliation with RORs
 - Subjects
 - Awards
 - Funders with RORs
 - Drag and drop file upload
 - Automatic DOI registration
 - Draft records
- Community record curation

The screenshot displays the INVENIORDM web interface. At the top, there is a navigation bar with the logo, a search bar, and links for 'Communities' and 'My dashboard'. Below this is a prompt to 'Select the community where you want to submit your record.' with a 'Select a community' button. The main content area is divided into sections: 'Files', 'Basic information', and 'Options'. The 'Files' section includes a 'Metadata-only record' checkbox, storage availability indicators, a large dashed box for 'Drag and drop files', and an 'Upload files' button. A warning message states: 'File addition, removal or modification are not allowed after you have published your upload.' The 'Basic information' section contains a 'Digital Object Identifier' field with radio buttons for 'Yes' and 'No', a text input for the DOI, and a 'Resource type' dropdown menu. The 'Title' field is also present. The 'Options' section includes an 'Apply an embargo' checkbox and a note: 'Record or files protection must be restricted to apply an embargo.' On the right side, there is a 'Draft' panel with 'Save draft', 'Preview', and 'Publish' buttons, and a 'Visibility' section with 'Public' and 'Restricted' options for both 'Full record' and 'Files only'.

Want to try it out? <https://inveniordm.web.cern.ch/>

Migration requirements

- Move all ~20,000 records and files
- Customize the repository for Caltech
 - Theming
 - ORCID
- Ensure API integrations continued to work



Migration strategy

- Relied on standard DataCite metadata
 - We used and validated our exporter as part of our backup and API work
 - https://github.com/caltechlibrary/caltechdata_api
- Exported all metadata and files
- Imported records using the InvenioRDM API
- Switched from old to new repository once all records were in place

Metadata enhancements

- ROR didn't exist when CaltechDATA started
 - Started with automatic mapping from <https://github.com/Metadata-Game-Changers/RORRetriever>, followed by manual verification
 - Mapped and split free-text affiliations
 - Mapped funders as well
- Other minor cleanup, like splitting subjects
- https://github.com/caltechlibrary/inveniordm-migrate/blob/master/migrate_caltechdata.py

Theming



California Institute of Technology
Research Data Repository

Search

Search records...



Data Sets



Software

Published March 20, 2023 | Version v1

The Materials Experiment Knowledge Graph

Statt, Michael¹ ; Rohr, Brian¹ ; Guevarra, Dan² ; Breeden, Ja'Nya² ; Suram, Santosh³; Gregoire, John²

Show affiliations

Citation

Style APA

Statt, M., Rohr, B., Guevarra, D., Breeden, J., Suram, S., & Gregoire, J. (2023). The Materials Experiment Knowledge Graph [Data set]. CaltechDATA. <https://doi.org/10.22002/h88fq-dk449>

Description

A Neo4j dump of the Materials Experiment Knowledge Graph (MEKG), a graph database containing metadata and experimental provenance from synthesis to measurement of primarily metal oxide solid state materials resulting from high throughput experimentation. The MEKG is a practical graph restructuring of the Materials Provenance Store, designed for greater querying efficiency through explicit entity relationships which would otherwise require slow table joins in the SQL paradigm. The higher search efficiency of long paths (equivalently multi-table joins) comes at the cost of slower aggregation operations.

Files

Name	Size	
public-release-neo4j-20230228.dump	5.5 GB	Download
<small>md5:340d15e83f6a78c09e36f19b10e594</small>		

Log in to CaltechDATA

Sign in with [access.caltech](#)

OR

Log in with a special account

Share

Versions

Version v1	Mar 20, 2023
10.22002/h88fq-dk449	

Details

DOI

DOI [10.22002/h88fq-dk449](#)

Resource type

Dataset

Publisher

CaltechDATA

Rights

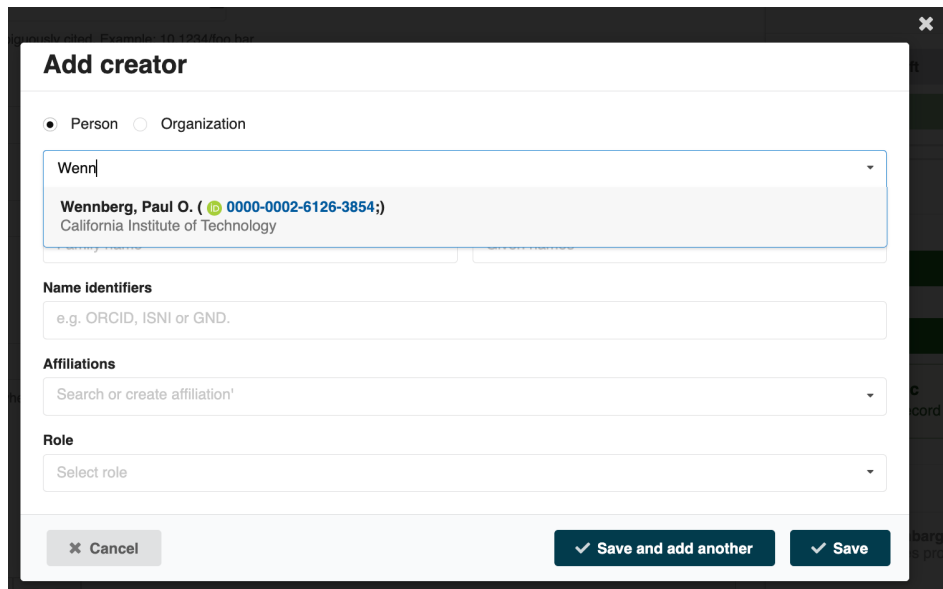
Creative Commons Attribution 4.0 International

About CaltechDATA

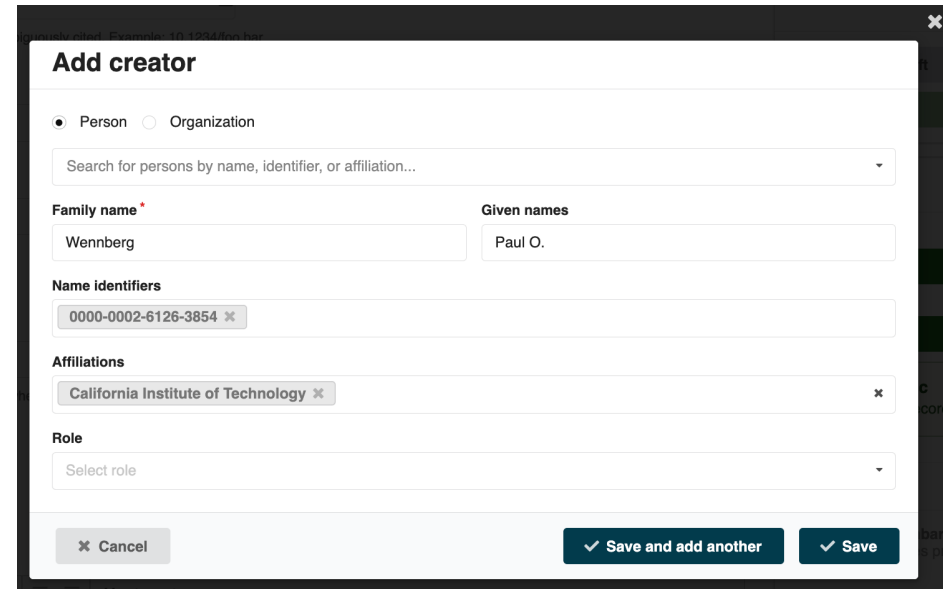
[FAQ](#) [News](#) [Terms](#) [Report a Problem](#) [Contact](#)

CaltechPEOPLE

- Library-wide effort to identify people associated with Caltech and their ORCIDS
- Powers our metadata service <https://feeds.library.caltech.edu/>
- Added to InvenioRDM as a name vocabulary



The screenshot shows the 'Add creator' form in InvenioRDM. At the top, there are radio buttons for 'Person' (selected) and 'Organization'. Below this is a search input field containing 'Wenn'. A dropdown menu is open, showing a search result for 'Wennberg, Paul O. (ORCID: 0000-0002-6126-3854;)' with the affiliation 'California Institute of Technology'. Below the search results are sections for 'Name identifiers' (with a placeholder 'e.g. ORCID, ISNI or GND.'), 'Affiliations' (with a search input 'Search or create affiliation'), and 'Role' (with a dropdown 'Select role'). At the bottom, there are three buttons: 'Cancel', 'Save and add another', and 'Save'.



The screenshot shows the 'Add creator' form in InvenioRDM with the manual entry fields filled out. At the top, there are radio buttons for 'Person' (selected) and 'Organization'. Below this is a search input field with the placeholder 'Search for persons by name, identifier, or affiliation...'. The 'Family name' field contains 'Wennberg' and the 'Given names' field contains 'Paul O.'. Below these are sections for 'Name identifiers' (with the value '0000-0002-6126-3854'), 'Affiliations' (with the value 'California Institute of Technology'), and 'Role' (with a dropdown 'Select role'). At the bottom, there are three buttons: 'Cancel', 'Save and add another', and 'Save'.

Automation with APIs

- Cell Atlas
- TCCON
- Micropublication

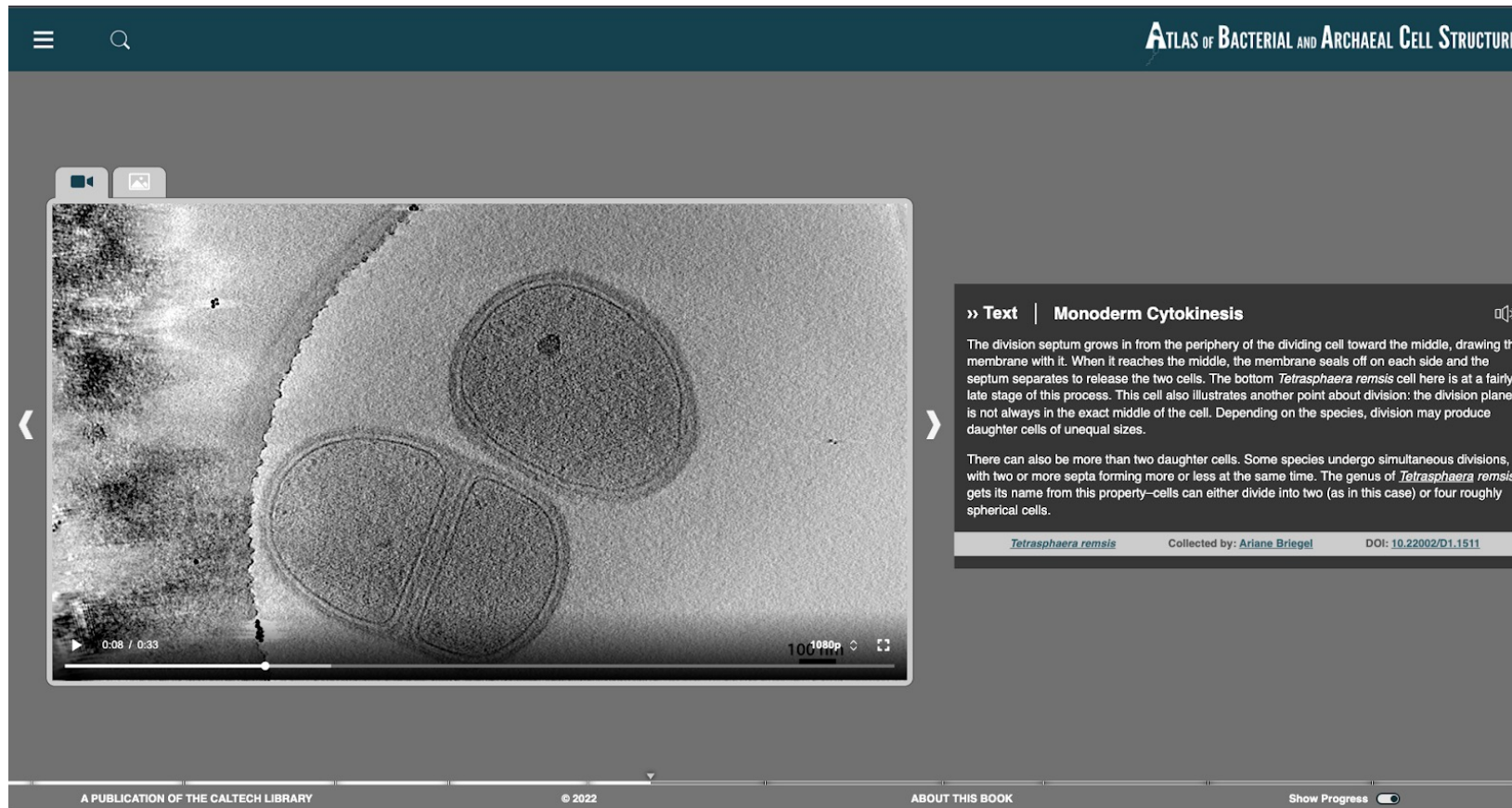


More details:

<https://www.cni.org/topics/digital-curation/a-sustainable-lightweight-approach-to-digital-content-management-and-publication>

CaltechDATA and the Cell Atlas

<https://cellstructureatlas.org>



The screenshot displays the 'ATLAS OF BACTERIAL AND ARCHAEAL CELL STRUCTURE' website. On the left, a video player shows a grayscale micrograph of a cell undergoing division. The video player includes a play button, a progress bar at 0:08 / 0:33, and a resolution indicator of 1080p. On the right, a text panel titled 'Monoderm Cytokinesis' provides a detailed description of the process. Below the text, it identifies the organism as *Tetrasphaera remsis*, collected by Ariane Briegel, with a DOI of 10.22002/D1.1511. The footer of the page includes 'A PUBLICATION OF THE CALTECH LIBRARY', '© 2022', 'ABOUT THIS BOOK', and a 'Show Progress' toggle.

» Text | Monoderm Cytokinesis

The division septum grows in from the periphery of the dividing cell toward the middle, drawing the membrane with it. When it reaches the middle, the membrane seals off on each side and the septum separates to release the two cells. The bottom *Tetrasphaera remsis* cell here is at a fairly late stage of this process. This cell also illustrates another point about division: the division plane is not always in the exact middle of the cell. Depending on the species, division may produce daughter cells of unequal sizes.

There can also be more than two daughter cells. Some species undergo simultaneous divisions, with two or more septa forming more or less at the same time. The genus of *Tetrasphaera remsis* gets its name from this property—cells can either divide into two (as in this case) or four roughly spherical cells.

Tetrasphaera remsis Collected by: Ariane Briegel DOI: 10.22002/D1.1511

- Open-access textbook on microbial cells
- Over 150 videos with text and narration
- Videos and other media stored in CaltechDATA; automatically created with CaltechDATA API

CaltechDATA and the Cell Atlas

- The v2.4 release was automatically uploaded to InvenioRDM version of CaltechDATA
- Only minor changes required (like addition of ROR identifiers)
- Now has built-in versioning

The screenshot shows the CaltechDATA record page for a PDF version of 'The Atlas of Bacterial and Archaeal Cell Structure'. The page includes a search bar, user profile, and navigation options. The main content area displays the title, authors (Oikonomou, Catherine and Jensen, Grant), data manager (Morrell, Thomas E), and project member (Badie, Kian). It also features a citation in APA style, a description of the PDF format, and a file viewer for 'AtlasEdition2.4.pdf'. On the right side, there are buttons for 'Edit', 'New version', and 'Share', along with a 'Versions' section showing the current version (v2.4) and a previous one (v2.3). The 'Keywords and subjects' section includes 'Atlas of Bacterial and Archaeal Cell Structure' and 'CryoEM'. The 'Details' section shows the DOI '10.22002/yb980-fv804' and the resource type.

Caltech DATA by Caltech Library

Search records...

Communities My dashboard + - tmorrell@c...

Published February 9, 2023 | Version v2.4

Text Open

PDF version the Atlas of Bacterial and Archaeal Cell Structure

Oikonomou, Catherine¹; Jensen, Grant²

Show affiliations

Data manager: Morrell, Thomas E¹

Project member: Badie, Kian

Show affiliations

Citation Style APA

Oikonomou, C., & Jensen, G. (2023). PDF version the Atlas of Bacterial and Archaeal Cell Structure (v2.4). CaltechDATA. <https://doi.org/10.22002/yb980-fv804>

Description

PDF format of version 2.4 of 'The Atlas of Bacterial & Archaeal Cell Structure' by Catherine M. Oikonomou & Grant J. Jensen

Files

AtlasEdition2.4.pdf

Page: 1 of 477 Automatic Zoom

Actions

- Edit
- New version
- Share

Versions

Version	Date
Version v2.4 10.22002/yb980-fv804	Feb 9, 2023
Version v2.3 10.22002/D1.20278	Aug 30, 2022

[View all 2 versions](#)

Keywords and subjects

Atlas of Bacterial and Archaeal Cell Structure CryoEM
Jensen Lab

Details

DOI

DOI 10.22002/yb980-fv804

Resource type

TCCON



Caltech DATA
by Caltech Library



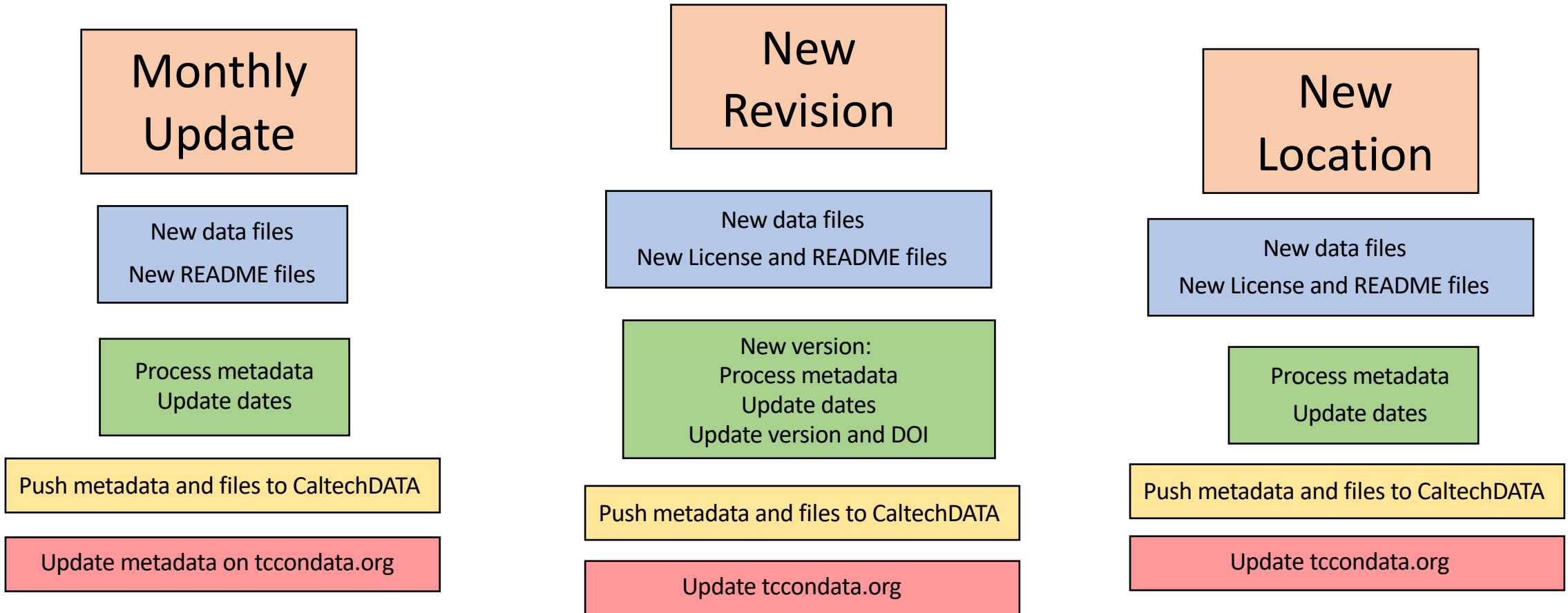
Data files →



Total Carbon Column Observing Network (TCCON)
29 Data Collection Sites Around the World

Data Curation and Processing

TCCON Automation



Improvements in InvenioRDM

Total Carbon Column Observing Network (TCCON)

<https://tcondata.org/>

+ New upload

About this community >

Search Requests Members Settings

Versions

View all versions

Resource types

Dataset 32

Help

[Search guide](#)

March 14, 2023 (2.0) Dataset Open

TARDISS Partial Column Retrieval Data

Parker, Harrison; Laughner, Joshua; Wennberg, Paul

Partial column (surface to 2 km and 2km to top of atmosphere)

Uploaded on March 14, 2023

2023 (R0) Dataset Metadata-only

TCCON data from Garmisch (DE), Release GGG2020.R0

Sussmann, R.; Rettinger, M.

The Total Carbon Column Observing Network (TCCON) measures the total column amount of atmospheric CO₂ in the near-infrared. From these spectra, CO₂, H₂O, and HDO, are retrieved.

Uploaded on February 22, 2023

2022 (R1) Dataset Metadata-only

TCCON data from Park Falls (US), Release GGG2020.R0

Total Carbon Column Observing Network (TCCON)

There is a **newer version** of the record available.

Published 2022 | Version R0

Dataset Metadata-only

TCCON data from Park Falls (US), Release GGG2020.R0

Wennberg, P. O.¹; Roehl, C. M.¹; Wunch, D.²; Toon, G. C.³; Blavier, J.-F.³; Washenfelder, R.⁴; Keppel-Aleks, G.⁵; Allen, N. T.⁶

Show affiliations

Contact person: Wennberg, Paul¹

Data curator: Roehl, C. M.¹

Hosting institution: California Institute of Technology, Pasadena, CA (US)

Related person: Ayers, J.²

Research group: TCCON

Show affiliations

Versions

Version R1 2022

10.14291/tcon.ggg2020.parkfalls01.R1

Version R0 2022

10.14291/tcon.ggg2020.parkfalls01.R0

[View all 2 versions](#)

Keywords and subjects

atmospheric trace gases CO₂ CH₄ CO N₂O

column-averaged dry-air mole fractions

remote sensing FTIR spectroscopy TCCON

Details

DOI

DOI [10.14291/tcon.ggg2020.parkfalls01.R0](https://doi.org/10.14291/tcon.ggg2020.parkfalls01.R0)

Resource type

Dataset

Publisher

Community Landing Page

Citation

Style APA

Wennberg, P. O., Roehl, C. M., Wunch, D., Toon, G. C., Blavier, J.-F., Washenfelder, R., Keppel-Aleks, G., & Allen, N. T. (2022). TCCON data from Park Falls (US), Release GGG2020.R0 (Version R0) [Data set]. CaltechDATA. <https://doi.org/10.14291/tcon.ggg2020.parkfalls01.R0>

Description

The Total Carbon Column Observing Network (TCCON) is a network of ground-based Fourier Transform Spectrometers that record direct solar

microPublication Biology

<https://www.micropublication.org/>

- Innovative journal for single findings
 - May be novel, negative, or reproduced
 - May lack an overall narrative
- Peer-reviewed
- Data files automatically uploaded to appropriate partner repositories

μP microPublication Biology
get your data out, be cited



microPublication Biology and CaltechDATA

- micropublication uses CaltechDATA for supplementary files that don't fit in a domain repository
- Part of our library publishing services
- Automated using the CaltechDATA API
- The micropublication team implemented this independently, and migrated independently

108 result(s) found Sort by Best match

Versions

View all versions

Resource types

- Dataset 57
- Video/Audio 15
- Model 9
- Software 9
- Interactive Resource 7
- Image 5
- Text 4
- Collection 1
- Workflow 1

Subjects

- drosophila 28

November 4, 2022 (1.0) Video/Audio [Open](#)

Audiovisual: Characterization of larval growth in *C. elegans* cuticle mutants
Nyaanga, Joy

Median length (x-axis) is plotted against median length (y-axis) to visualize changes in body aspect ratio over time. Each point corresponds to the median length or median width of animals at each experimental hour. Post-molt relaxation is observed in WT, lon-3(e2175), and dpy-1(e1) as a slight decrease in median animal width. Post-molt relaxati...

Uploaded on November 4, 2022

November 4, 2022 (1.0) Video/Audio [Open](#)

Image: Dynamics of changes in apical cell area during sex comb rotation in *Drosophila melanogaster*.
Malagon, Juan Nicolas

Video. Time lapse movie of the sex comb rotation in *Drosophila melanogaster*. Scale bar = 20 μm .

Uploaded on November 4, 2022

November 7, 2022 (1.0) Text [Open](#)

Text: High-MOI induces rapid CRISPR spacer acquisition in *Sulfolobus* from an acr deficient virus
Bhoobalan-Chitty, Yuvaraj

List of spacer sequences newly acquired upon infection with SIRV2M (column 1) and their PAM sequence (column 2). The CRISPR-Cas subtypes capable of utilizing each new spacer is specified (column 3) along with the location of the spacer in the SIRV2 genome (column 4). Spacer complementarity to sense strand (column 1) is especially important for t...

Uploaded on November 8, 2022

Migration Completed!

- We successfully migrated all content by our contract deadline
- API integrations continue to work
- Significant improvements to landing pages and versioning
- GitHub support coming soon



CaltechAUTHORS

- Over 100,000 records of work by Caltech authors
- Hosted in Eprints since 2004

Google organic chemistry pdf

About 652,000,000 results (0.63 seconds)

[https://chemistry.ucr.edu/~rowecm2681/files/PDF/Chapter 1 Organic Molecules and C](https://chemistry.ucr.edu/~rowecm2681/files/PDF/Chapter%201%20Organic%20Molecules%20and%20C.pdf)
by RC Neuman Jr · Cited by 3 — Organic chemistry preparation, and reactions of a vast array of molecu
56 pages

https://authors.library.caltech.edu/Organic_Chemistry
Organic chemistry - Caltech Authors
The success achieved by this book's forerunners, B
Modern Organic Chemistry, was to a considerable e
864 pages

ORGANIC CHEMISTRY
methane to macromolecules

JOHN D. ROBERTS
California Institute of Technology

ROSS STEWART
University of British Columbia

MARJORIE C. CASERIO
University of California, Irvine

W. A. BENJAMIN, INC.
New York, 1971

Google chemical reaction engineering pdf

About 307,000,000 results (0.60 seconds)

<https://authors.library.caltech.edu/FundChemReax...> PDF
Fundamentals of Chemical Reaction Engineering - Caltech
by ME Davis · 2003 · Cited by
Published by McGraw-Hill, a l

[https://authors.library.caltech.edu/Fundamentals of c](https://authors.library.caltech.edu/Fundamentals_of_Chemical_Reaction_Engineering)
Fundamentals of Chemical Reaction Engineering
by ME Davis · 2003 · Cited
Chemical Reaction Engine
Series Name: McGraw-Hill

Mark E. Davis
California Institute of Technology

Robert J. Davis
University of Virginia

McGraw Hill

Boston Burr Ridge, IL Dubuque, IA Madison, WI New York San Francisco St. Louis
Bangkok Bogotá Caracas Kuala Lumpur Lisbon London Madrid Mexico City
Milan Montreal New Delhi Santiago Seoul Singapore Sydney Taipei Toronto

Google rate of change calculus problems with solutions pdf

About 16,600,000 results (0.92 seconds)

[https://authors.library.caltech.edu/...](https://authors.library.caltech.edu/Rates_of_Change_and_the_Chain_Rule) PDF
Rates of Change and the Chain Rule
by JE Marsden · 1985 · Cited by 104 — Solu
equation of a straight line with this slope is
39 pages

Chapter 2
Rates of Change and the Chain Rule

The rate at which one variable is changing with respect to another can be computed using differential calculus.

In Chapter 1, we learned how to differentiate algebraic functions and, thereby, to find velocities and slopes. In this chapter, we will learn some applications involving rates of change. We will also develop a new rule of differential calculus called the chain rule. This rule is important for our study of related rates in this chapter and will be indispensable when we come to use trigonometric and exponential functions.

2.1 Rates of Change and the Second Derivative

If $y = f(x)$, then $f'(x)$ is the rate of change of y with respect to x .

The derivative concept applies to more than just velocities and slopes. To explain these other applications of the derivative, we shall begin with the situation where two quantities are related linearly.

Suppose that two quantities x and y are related in such a way that a change Δx in x always produces a change Δy in y which is proportional to Δx ; that is, the ratio $\Delta y/\Delta x$ equals a constant, m . We say that y changes *proportionally or linearly* with x .

For instance, consider a hanging spring to which objects may be attached. Let x be the weight of the object in grams, and let y be the resulting length of the spring in centimeters. It is an experimental fact called Hooke's law that (for values of Δx which are not too large) a change Δx in the weight of the object produces a proportional change Δy in the length of the spring. (See Fig. 2.1.1.)

If we graph y against x , we get a segment of a straight line with slope

$$m = \frac{\Delta y}{\Delta x}$$

as shown in Fig. 2.1.2. The equation of the line is $y = mx + b$, and the

Figure 2.1.1. Hooke's law states that the change in length Δy is proportional to the change in weight Δx .

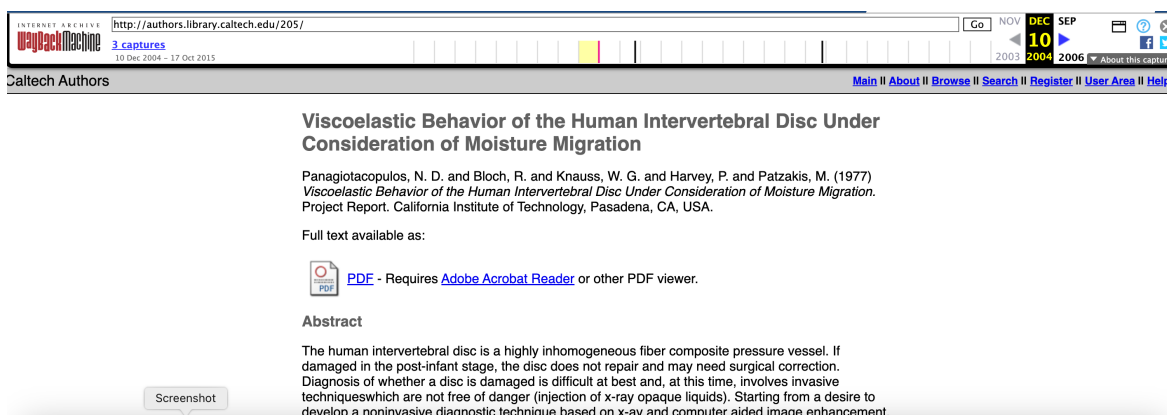
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Viscoelastic Behavior of the Human Intervertebral Disc Under Consideration of Moisture Migration

Panagiotacopoulos, N. D. and Bloch, R. and Knauss, W. G. and Harvey, P. and Patzakis, M. (1977) *Viscoelastic Behavior of the Human Intervertebral Disc Under Consideration of Moisture Migration*. Project Report. California Institute of Technology, Pasadena, CA, USA.

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Abstract

The human intervertebral disc is a highly inhomogeneous fiber composite pressure vessel. If damaged in the post-infant stage, the disc does not repair and may need surgical correction. Diagnosis of whether a disc is damaged is difficult at best and, at this time, involves invasive techniques which are not free of danger (injection of x-ray opaque liquids). Starting from a desire to develop a noninvasive diagnostic technique based on x-ray and computer aided image enhancement,

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Organic Chemistry: Methane to Macromolecules

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Abstract

The success achieved by this book's forerunners, *Basic Principles of Organic Chemistry* and *Modern Organic Chemistry*, was to a considerable extent due to the rigor with which the subject of organic chemistry was presented. In the present work we have tried to paint an interesting, relevant, and up-to-date picture of organic chemistry while retaining the rigorous approach of the earlier books. Organic chemistry sometimes appears to be enormously complex to the beginning student, particularly if he must immediately grapple with the subjects of structural isomerism and nomenclature. We have attempted to avoid this difficulty in the following way. Chapter 1 briefly relates carbon to its neighbors in the Periodic Table and reviews some fundamental concepts. Chapter 2 deals with the four C1 and C2 hydrocarbons-methane, ethane, ethene, and ethyne-and discusses their conformational and configurational properties and some of their chemical reactions. The reader thus makes an acquaintance with the properties of some important organic compounds before dealing in an open-ended way with families of compounds-alkanes, alcohols, etc. A heavy emphasis on spectroscopy is retained but the subject is introduced somewhat later than in the earlier books. Important additions are chapters dealing with enzymic processes and metabolism and with cyclization reactions. Many of the exercises of the earlier books have been retained and have been supplemented with drill-type problems. It seems a shame to burden the mind of the beginning student with trivial names, some of them quite illogical, and throughout we have stressed IUPAC nomenclature, which is both logical and easy to learn. The instructor, who may well carry lightly the


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Chemical principles. Third edition.

Dickerson, Richard E.; Gray, Harry B.; Haight, Gilbert P.

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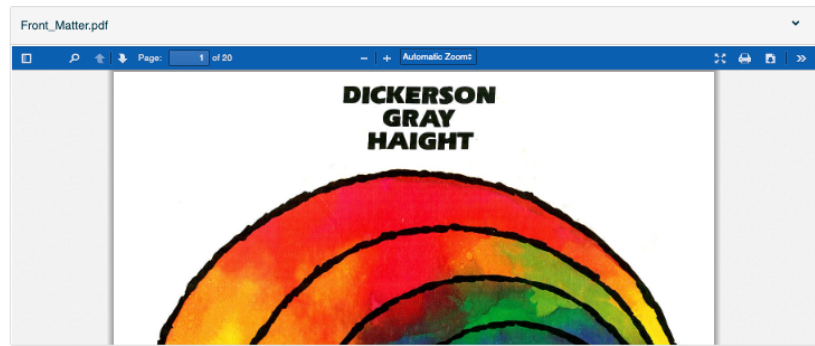
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Dickerson, R. E., Gray, H. B., & Haight, G. P. (1979). Chemical principles. Third edition. The Benjamin/Cummings Publishing Company, Inc. <https://doi.org/None>

Description

PREFACE: This edition of Chemical Principles, like its predecessors, is designed to be used in a general university chemistry course which must provide both an overview of chemistry for nonspecialists and a sound foundation for later study for science or chemistry majors. Hence there are several survey chapters introducing different areas of chemistry, including inorganic, nuclear, organic, and biochemistry, and an attempt is made throughout the book to place chemistry in its historical and cultural setting. At the same time, the quantitative aspects of chemistry are presented in a manner consistent with their importance, in a way that will make it easy to build upon them in later courses. This is the first complete revision of Chemical Principles since the first edition was published in 1969. The authors have rethought and replanned the entire book, especially the first thirteen chapters, trying to make it a better pedagogical tool without losing the special viewpoints and flavor that made the earlier editions so successful. The history and the anecdotal asides that help to make the subject palatable have been retained, but they have been better segregated from the factual material for which a student will be held responsible.

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