

NDSF: "new dispersed systems formalism"

**A tool for description and innovation,
but also for scientific investigation**

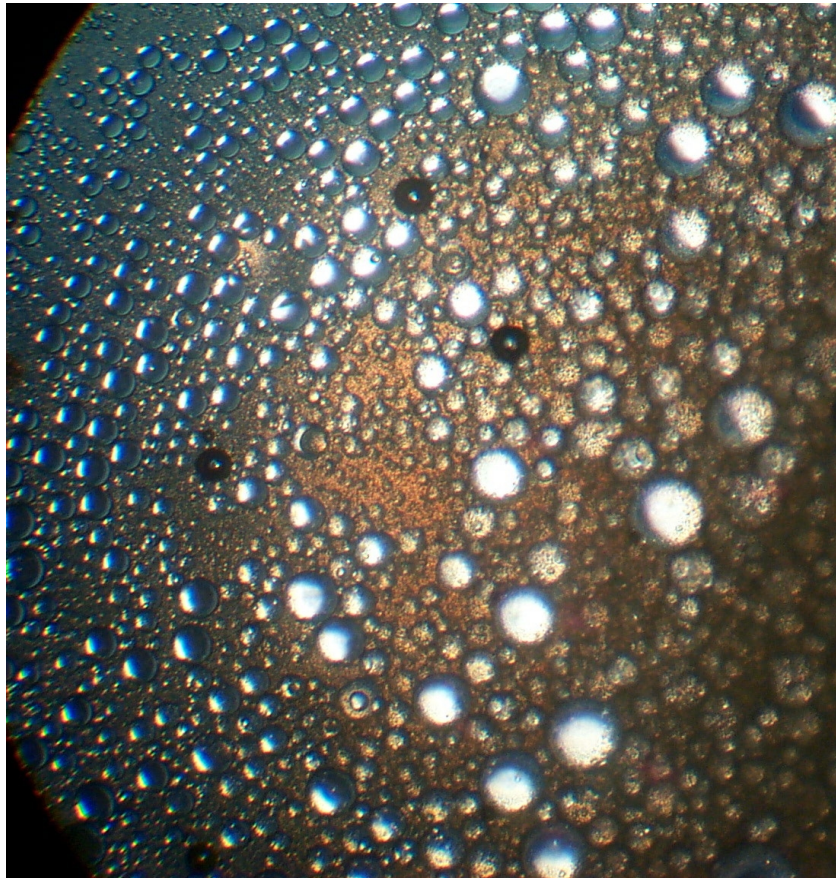
What is food ?



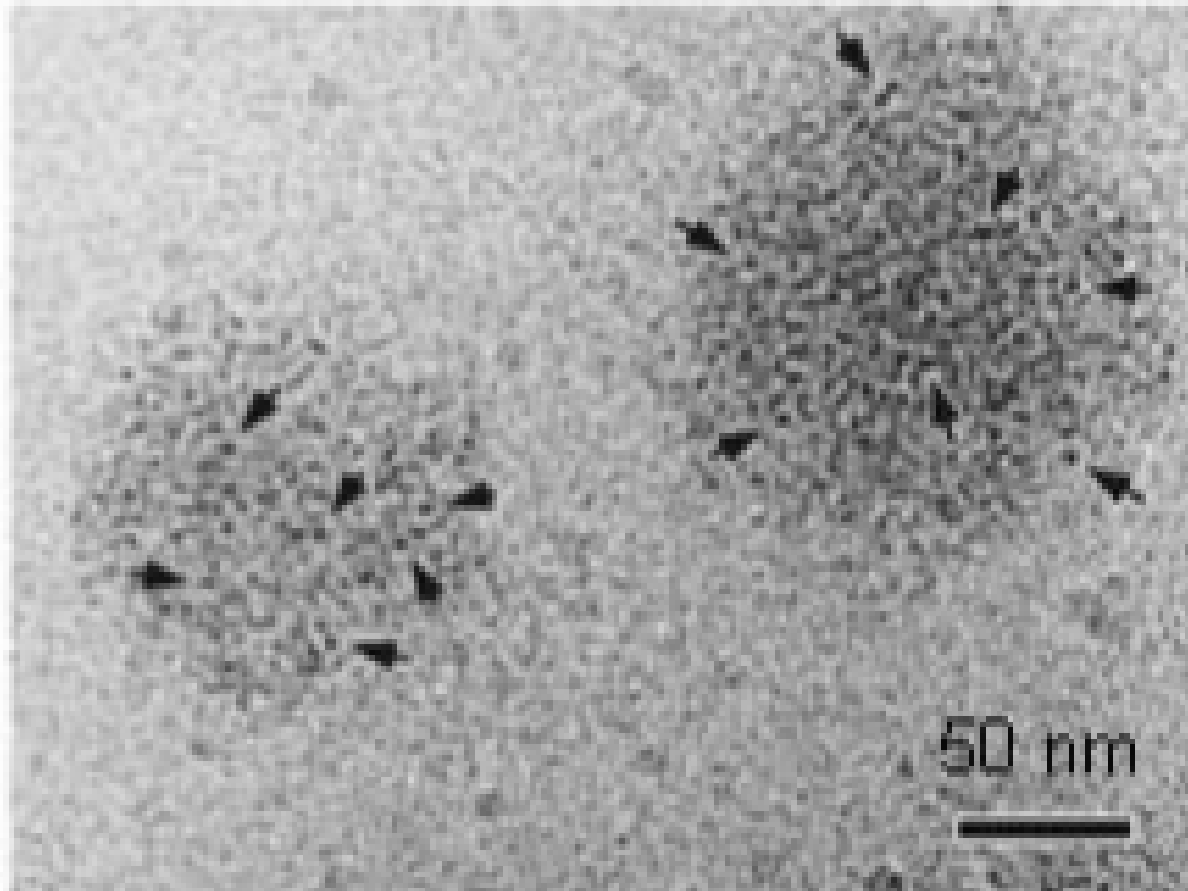
A macroscopic organization



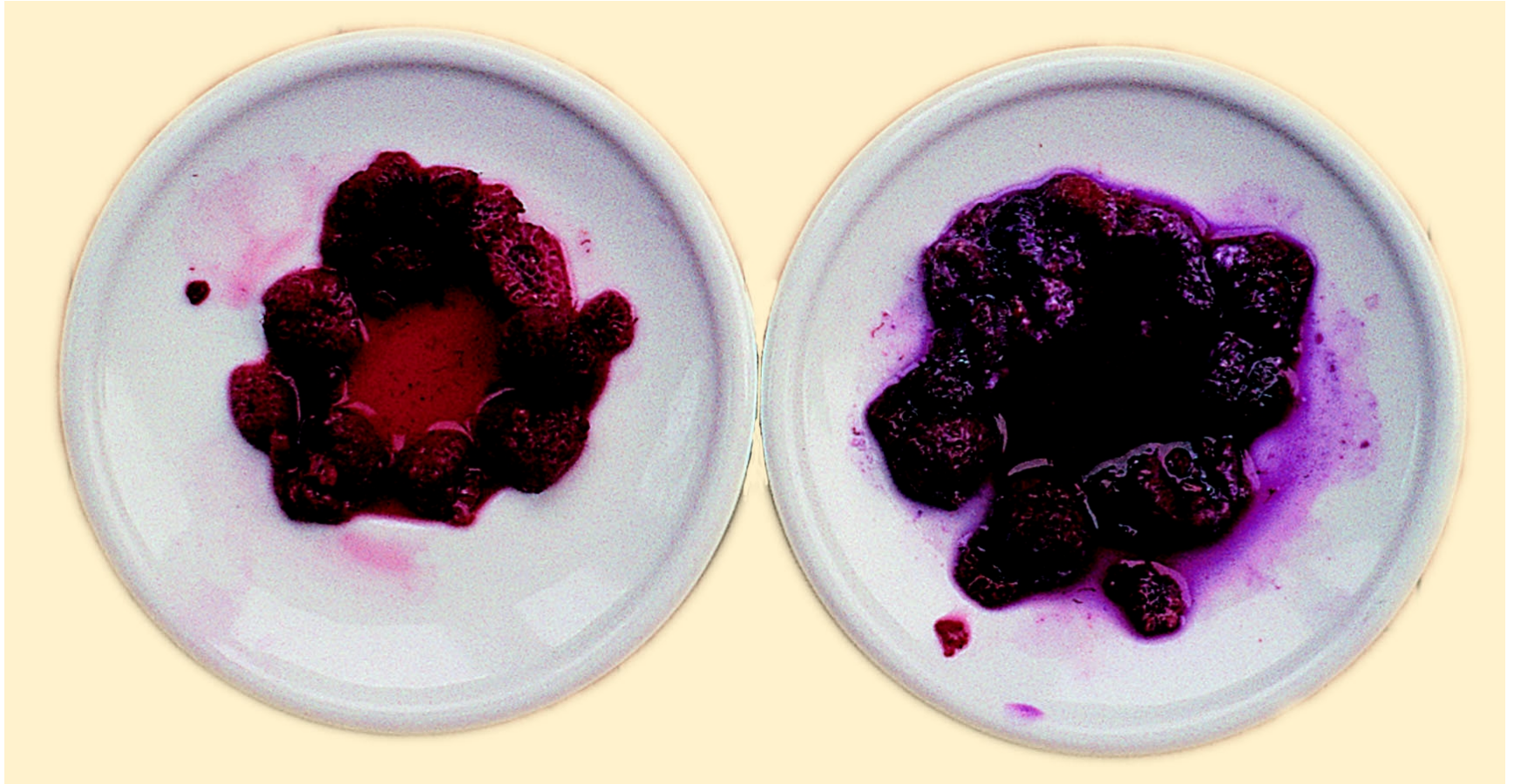
For each part, a microscopic organization



For each part, a mesoscopic organization



And also a supramolecular organization



Formalism is fruitful

« Pour l'Algèbre de la logique, ses inventeurs n'ont certainement jamais songé à y voir autre chose qu'une notation des concepts, relations et opérations élémentaires dont s'occupent les logiciens et ne se font aucune illusion sur la différence qui sépare de la découverte d'une vérité l'invention d'une notation propre à l'exprimer quand elle sera découverte. D'ailleurs, **la notation peut conduire à la découverte**, comme cela est arrivé constamment en algèbre. A des concepts généraux et abstraits, qui, sans le secours d'aucun signe, ne seraient aucunement maniables, et qui sont lourds et incommodes à manier au moyen des mots du langage vulgaire, l'algèbre de la logique, comme l'algèbre ordinaire, **substitue des symboles concrets et réguliers qui se prêtent à des combinaisons infinies et ramène de laborieuses opérations de l'esprit à de très faciles opérations de plume** ».

Edmond Goblot, Traité de logique, Armand Colin, 1918, p. 18

An inspiration

« Pour mieux faire sentir [...] l'état de la question, et pour présenter aux yeux, sous un même coup d'œil, le résultat de ce qui se passe dans les dissolutions métalliques, **j'ai construit des espèces de formules**, qu'on pourrait prendre d'abord pour des formules algébriques, mais qui ne dérivent point des mêmes principes ; nous sommes encore bien loin de pouvoir porter dans la chimie la précision mathématique, et je prie en conséquence, de ne considérer les formules que je vais donner que comme de simples annotations, dont l'objet est de soulager les opérations de l'esprit ».

Lavoisier AL, Considérations générales sur la dissolution des métaux dans les acides, 1782, p. 492 (repris dans les Œuvres, t. III)

NDSF formalism

Operators:

- \ : including a random dispersion of
- + : coexistence of phases, mixture
- $\supset$: inclusion
- σ : superposition (according to x,y,z)
- X : intermixing of two phases

Dimensions

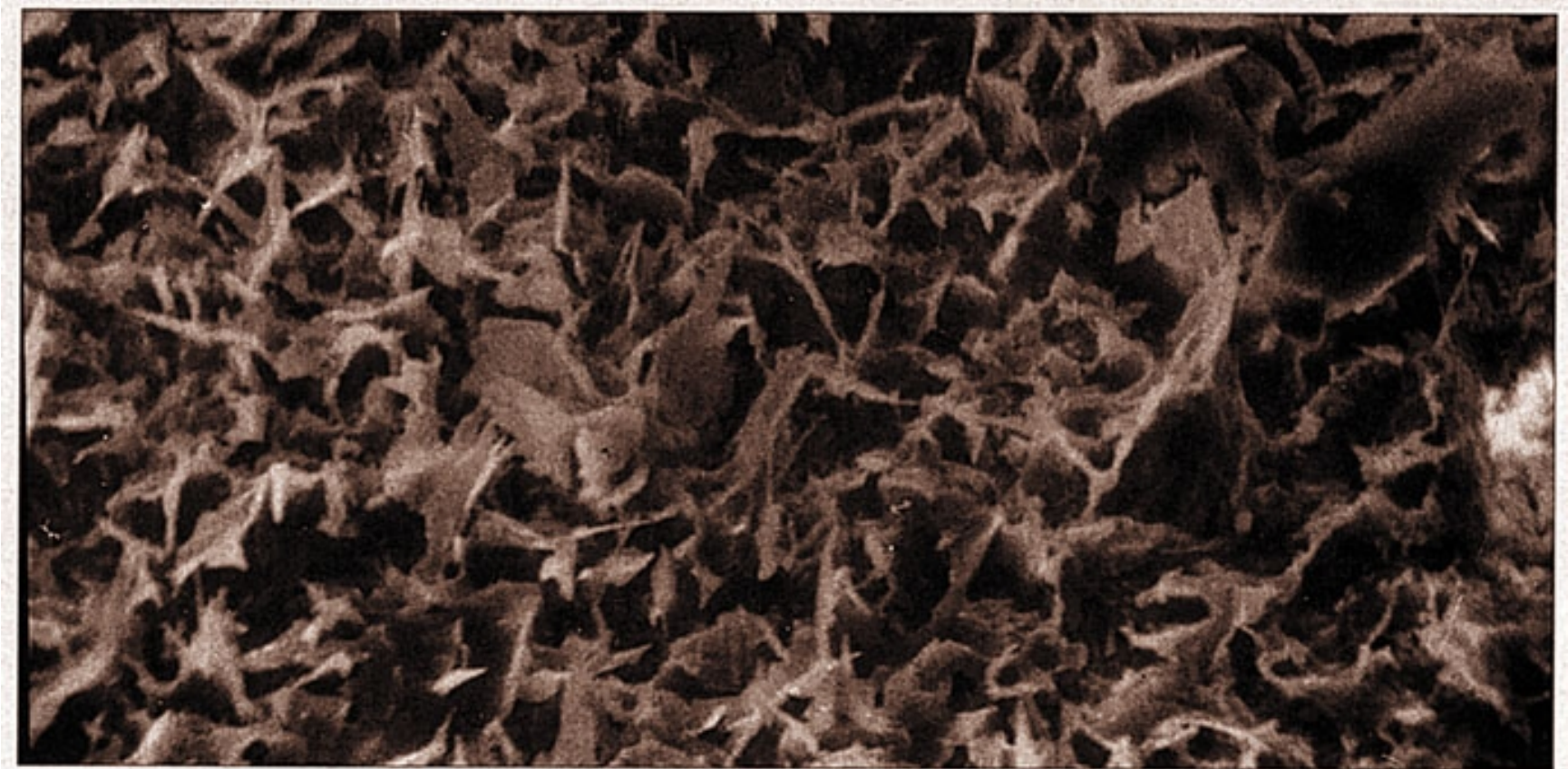
- D0 : dots
- D1: lines
- D2: sheets
- D3: blocks

Phases :

- G : gas
- W : aqueous solutions
- O : oil
- S1, S2, ... : solids

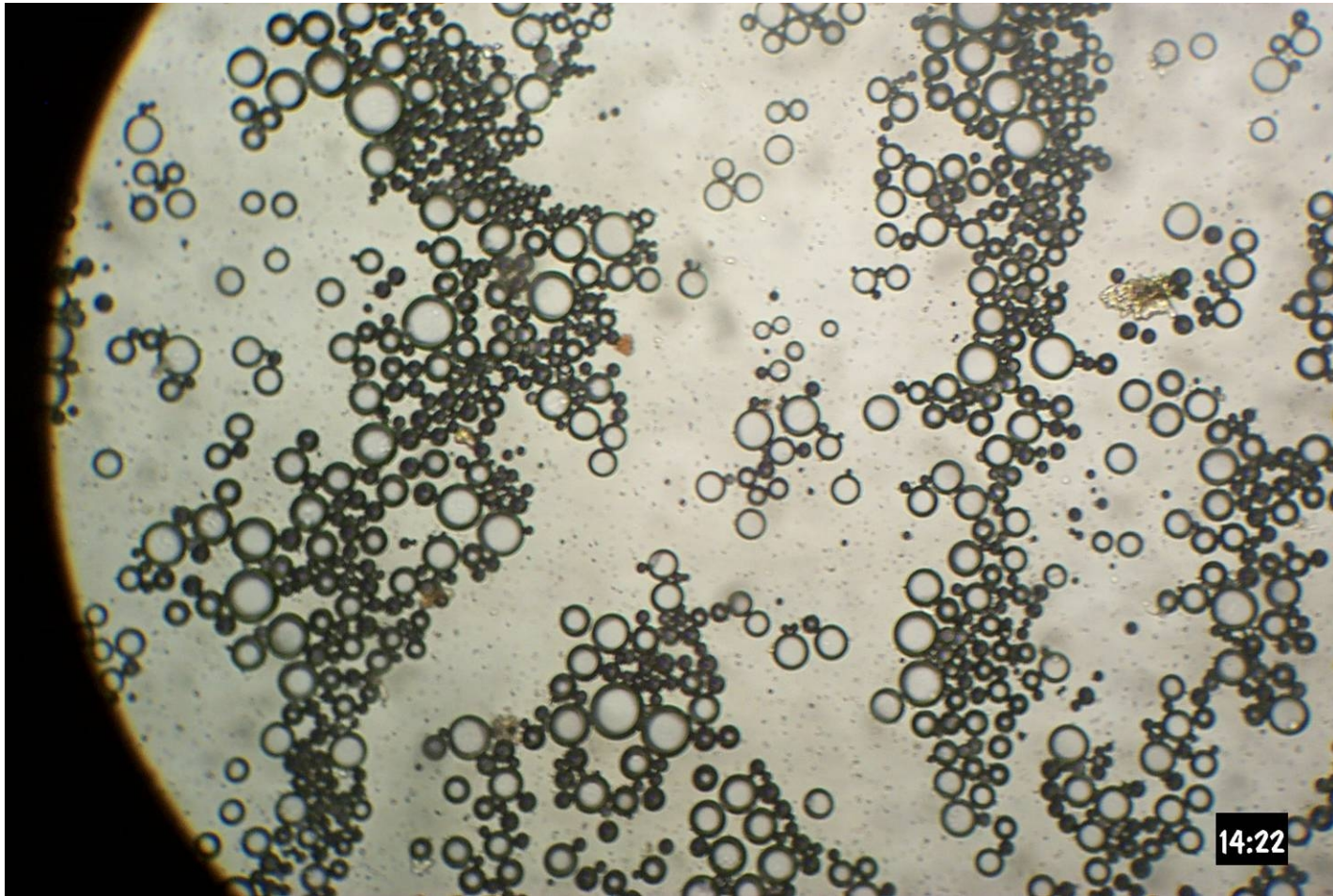
Chocolate :

some liquid fat is hidden among fat crystals, sugar crystals, plant materials (depending of course on temperature!)



This vo Kientza H. 2023. About Aguilera et al. (2004): chocolate, migration of lipids, diffusion and capillarity, International Journal of Molecular and Physical Gastronomy, 11, 1-9.

The “cream” of espresso coffee is a simple foam (not an emulsion)



IUPAC Gold Book

foam

Online use... ▾



<https://doi.org/10.1351/goldbook.F02467>

A dispersion in which a large proportion of gas by volume in the form of gas bubbles, is dispersed in a liquid, solid or gel. The diameter of the bubbles is usually larger than 1 μm , but the thickness of the lamellae between the bubbles is often in the usual colloidal size range. The term froth has been used interchangeably with foam. In particular cases froth may be distinguished from foam by the fact that the former is stabilized by solid particles (as in froth flotation q.v.) and the latter by soluble substances.

Sources:

Cite as: IUPAC. *Compendium of Chemical Terminology*, 2nd ed. (the "Gold Book"). Compiled by A. D. McNaught and A. Wilkinson. Blackwell Scientific Publications, Oxford (1997). Online version (2019-) created by S. J. Chalk. ISBN 0-9678550-9-8. <https://doi.org/10.1351/goldbook>.

Div. I

PDF

Text

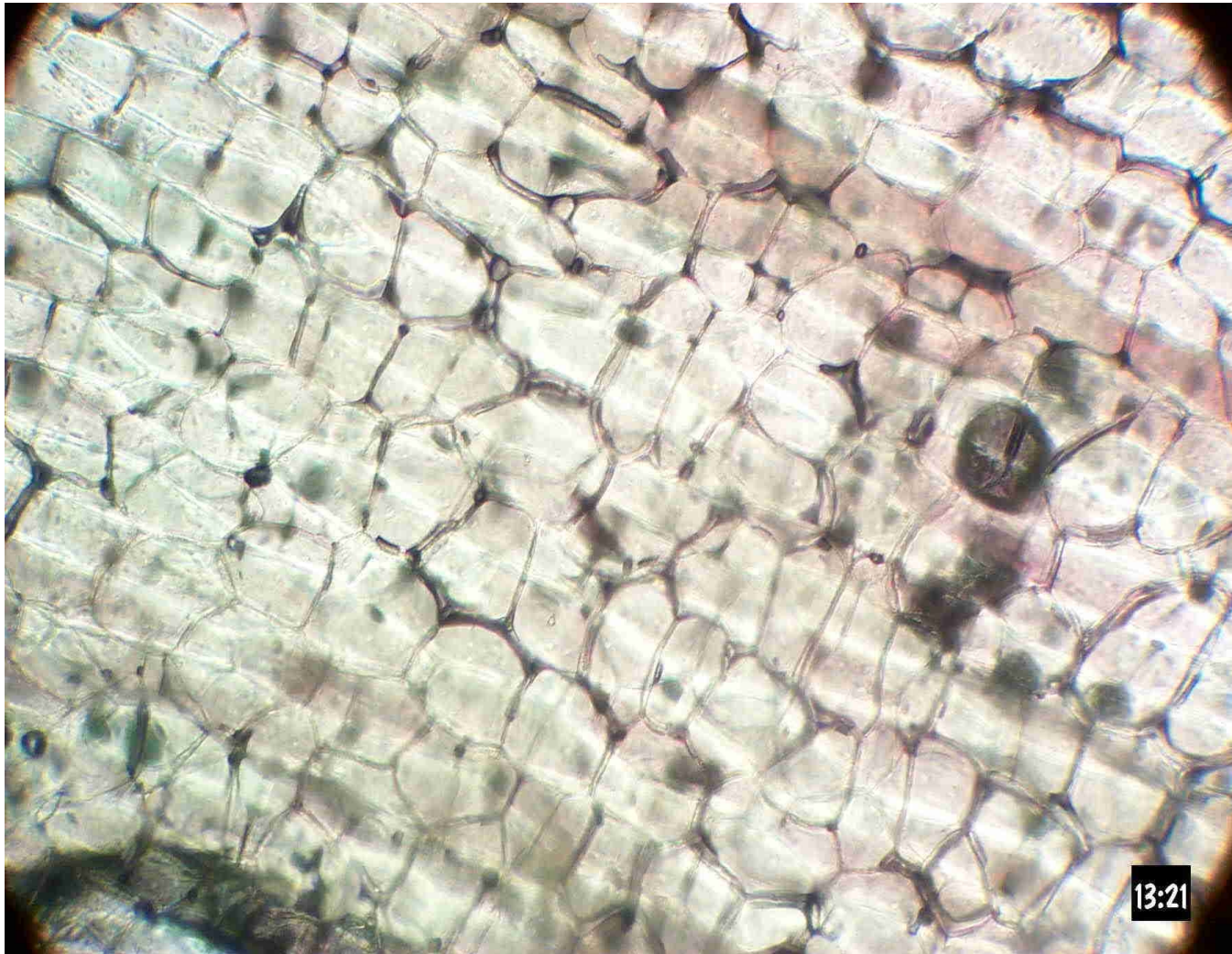
JSON

History

Feedback

Last revised: February 24, 2014

Plant tissues are formally gels



Hervé This, Statgels and dynagels, 2016 Notes Académiques de l'Académie d'agriculture de France, / Academic Notes from the French Academy of Agriculture, 12, 1-12.

IUPAC Gold Book

gel

Online use... ▾



<https://doi.org/10.1351/goldbook.G02600>

Non-fluid colloidal network or polymer network that is expanded throughout its whole volume by a fluid.

Notes:

1. A gel has a finite, usually rather small, yield stress.
2. A gel can contain:

Cite as: IUPAC. *Compendium of Chemical Terminology, 2nd ed. (the "Gold Book"). Compiled by A. D. McNaught and A. Wilkinson. Blackwell Scientific Publications, Oxford (1997). Online version (2019-) created by S. J. Chalk. ISBN 0-9678550-9-8. <https://doi.org/10.1351/goldbook>.*

Div. IV

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Text

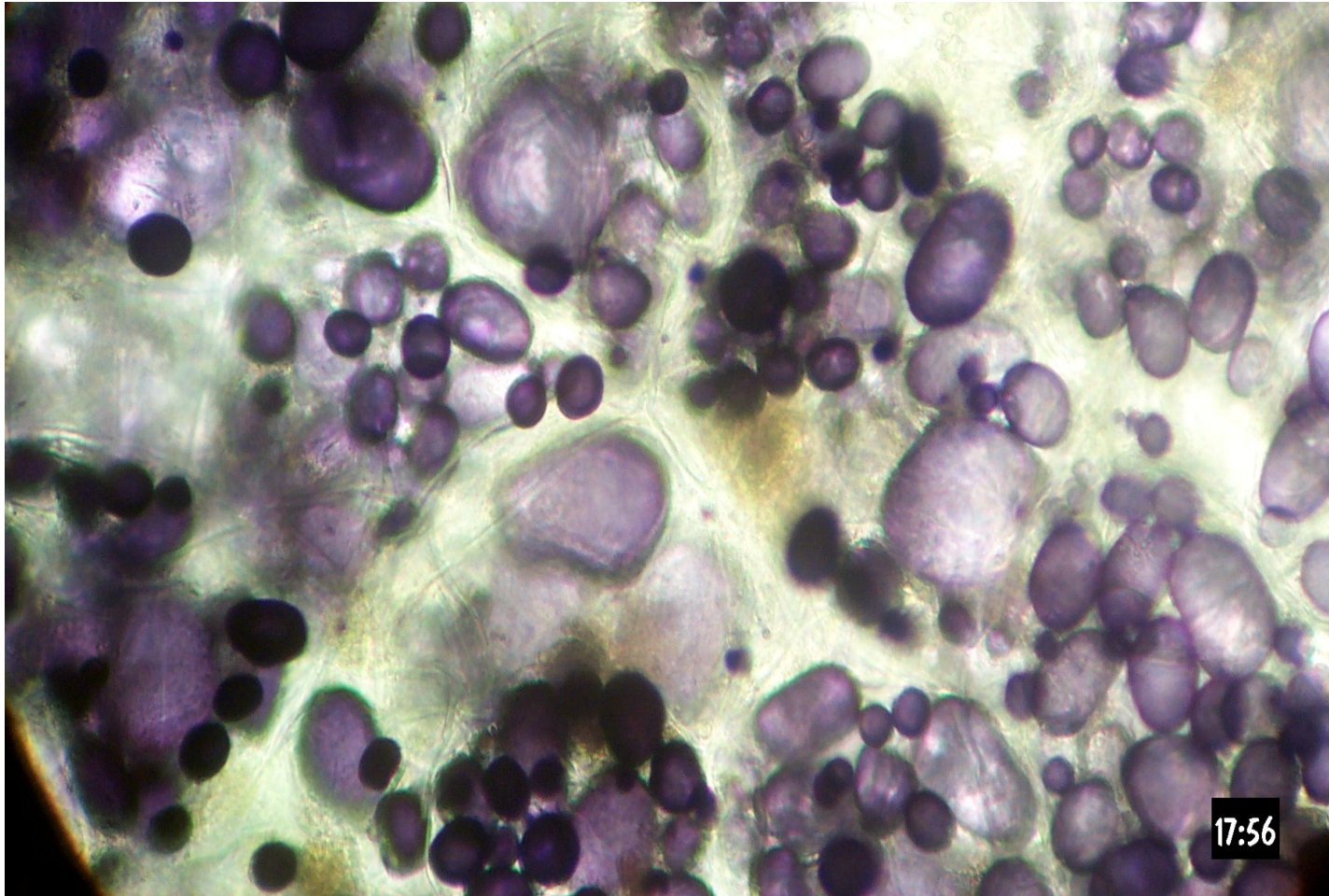
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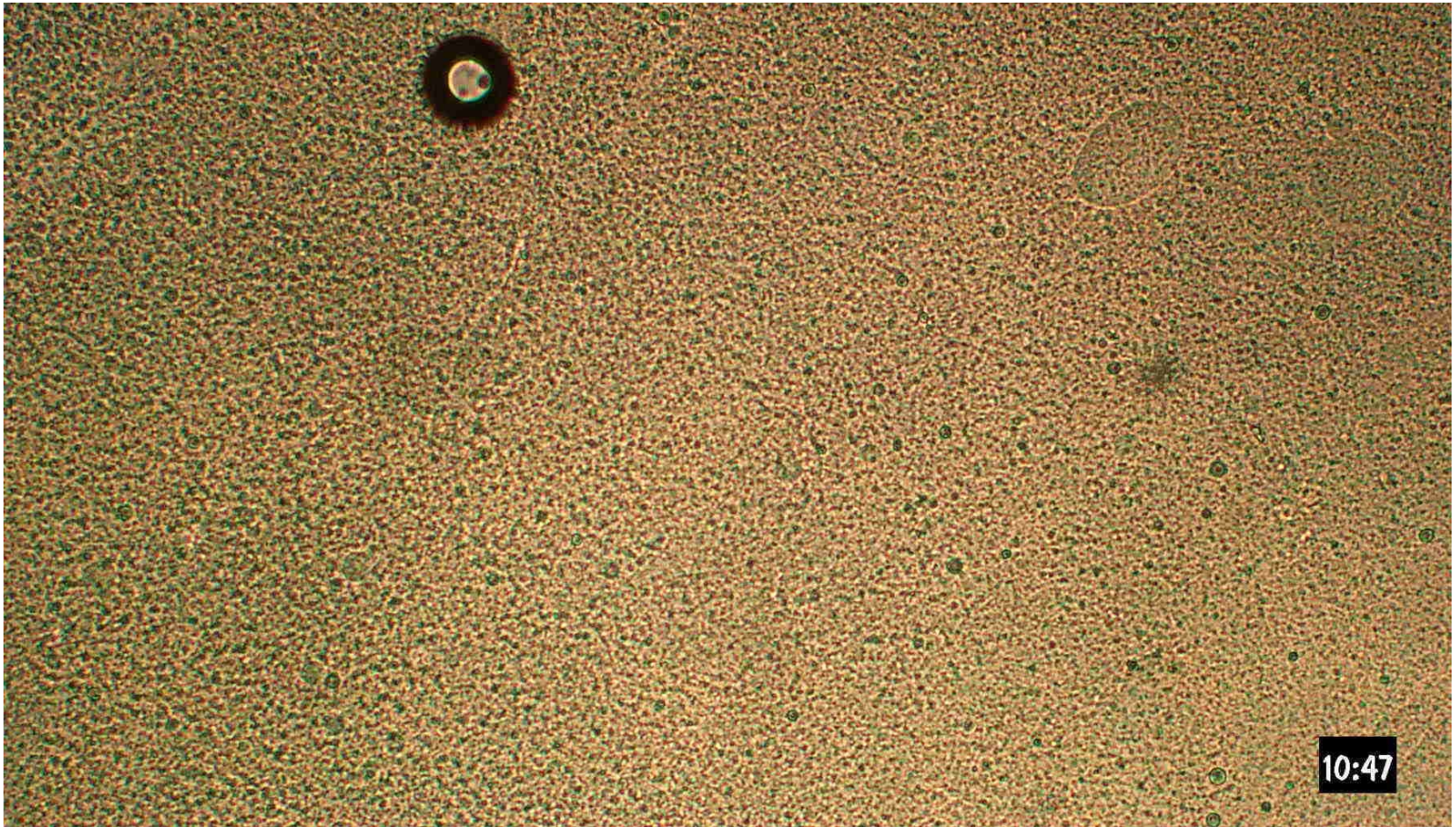
Last revised: February 24, 2014

Even when cells contain starch granules (here potato stained with iodine)

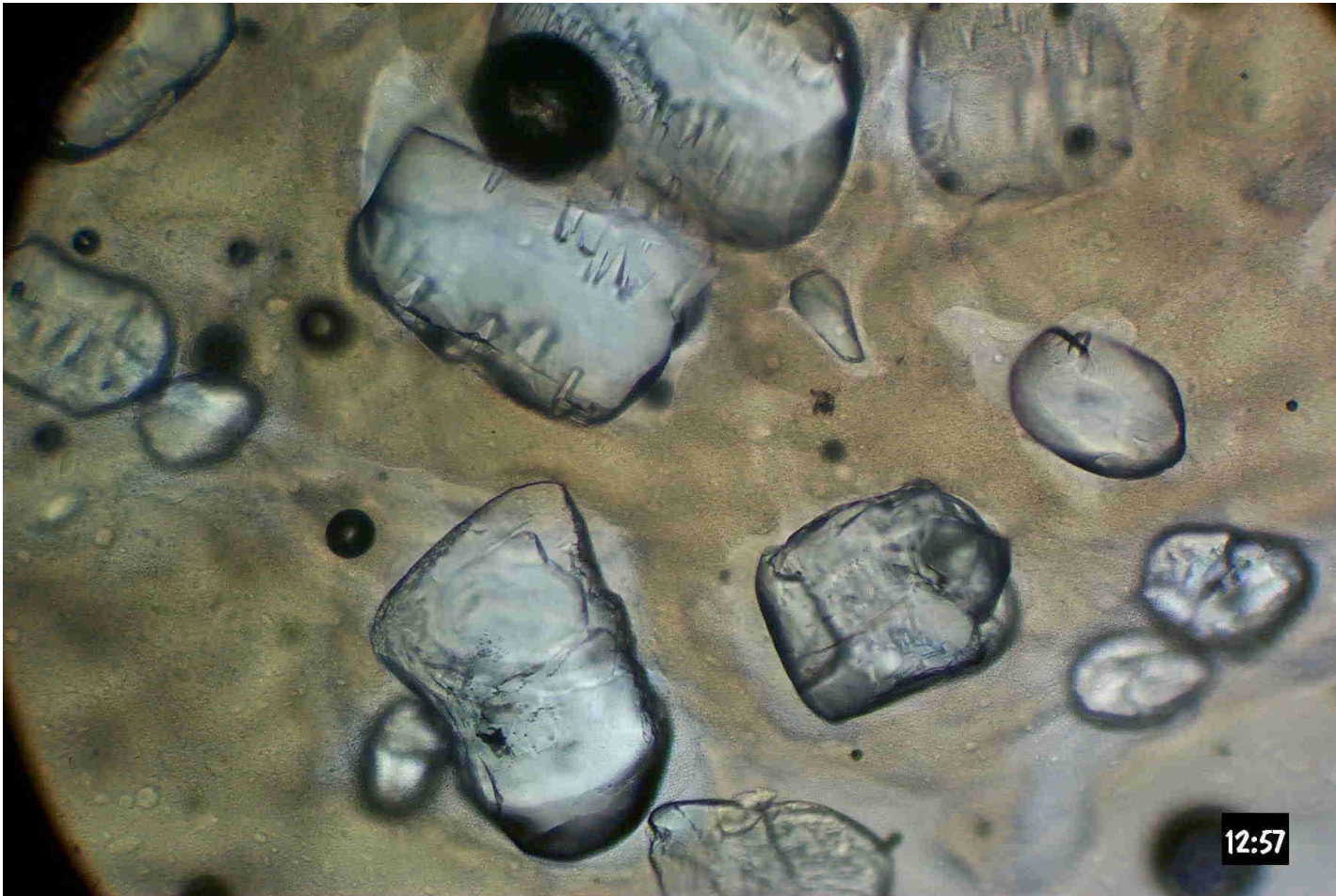


Hervé This. Molecular Gastronomy, a chemical look to cooking. Accounts of Chemical Research, May 2009, vol 42, N°5, pp. 575-583, Published on the Web 05/19/2009 www.pubs.acs.org/acr, doi10.1021/ar8002078.

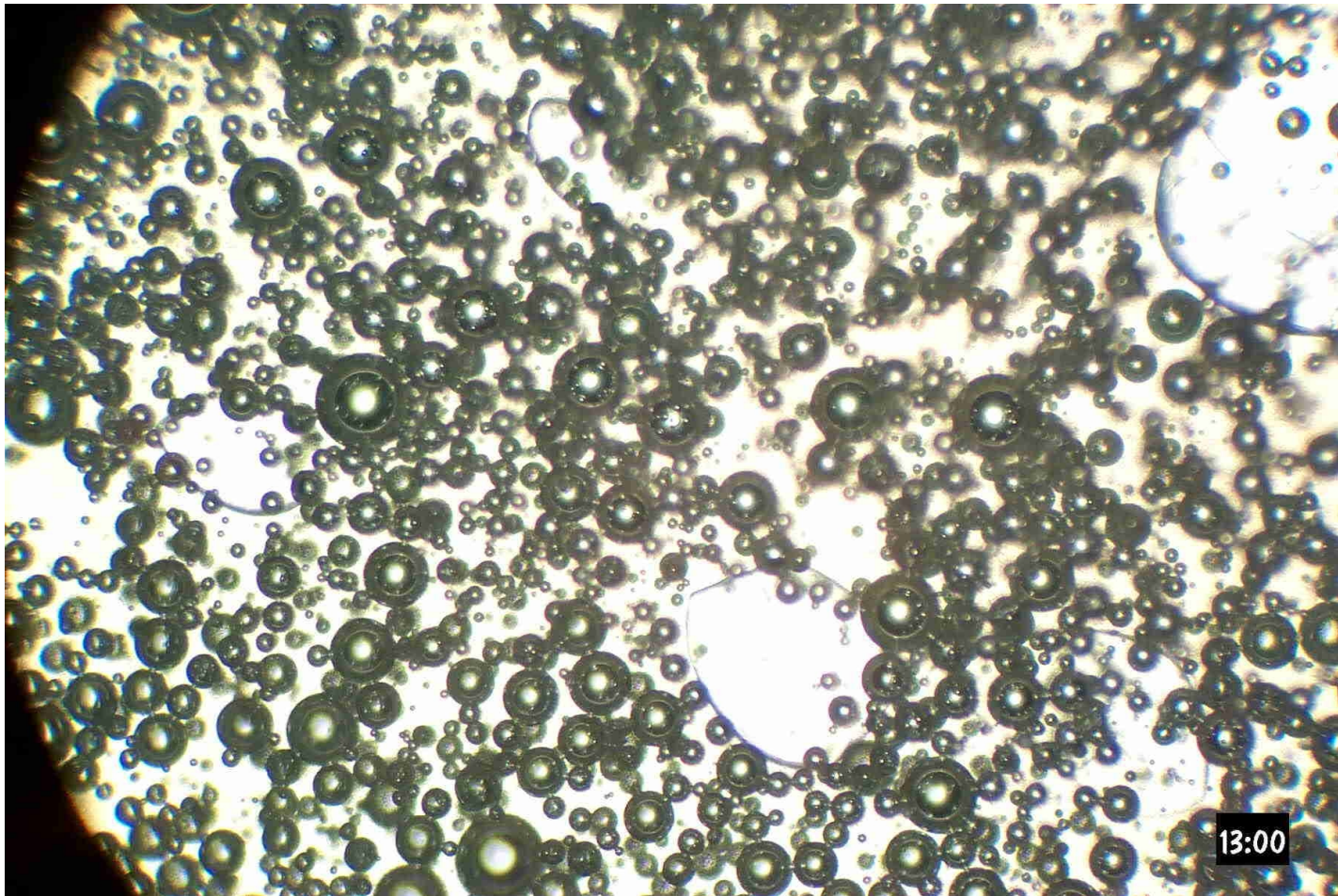
Egg yolks : a dispersion of granules in a plasma



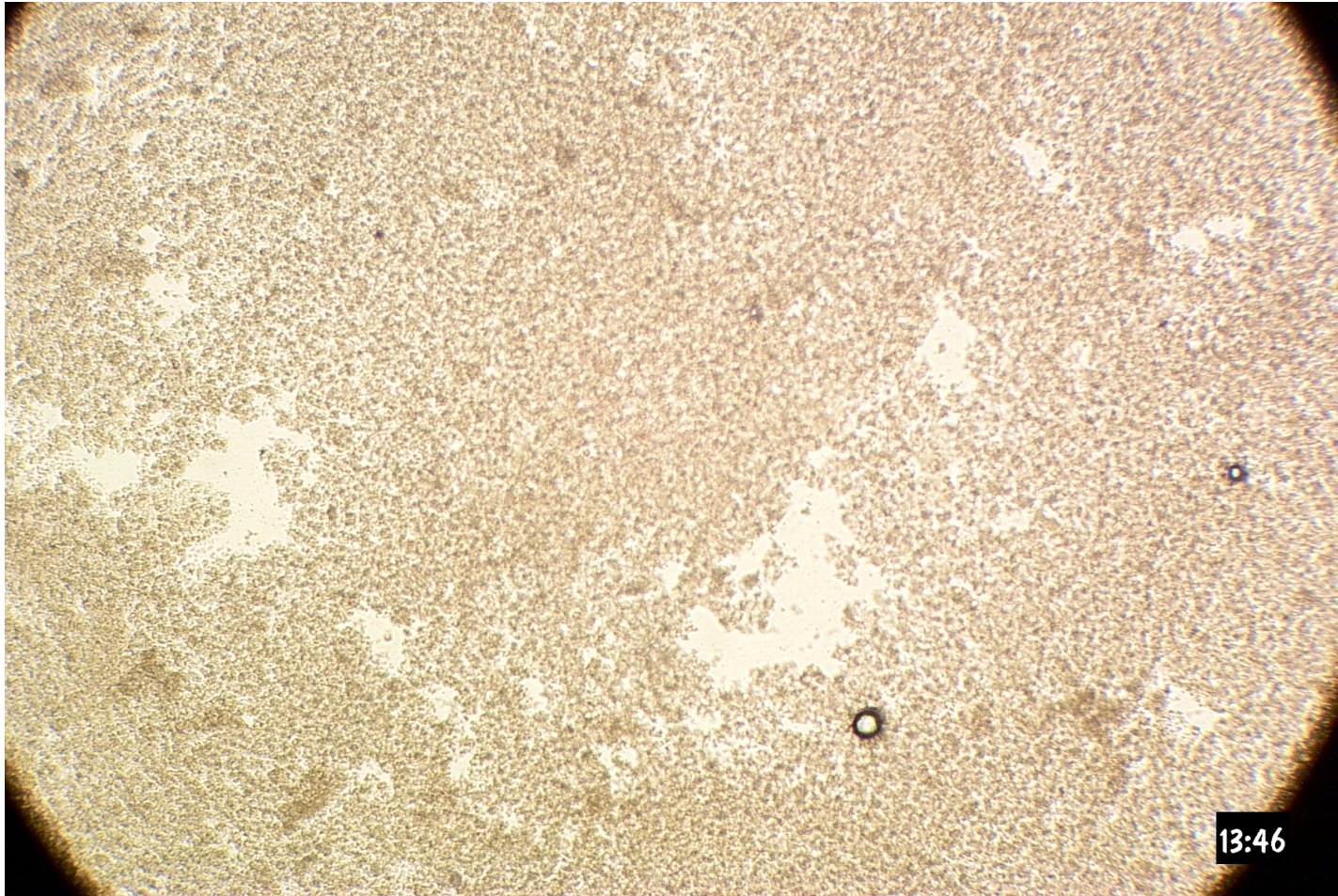
**When you add sugar,
in order to make a custard (for example)**



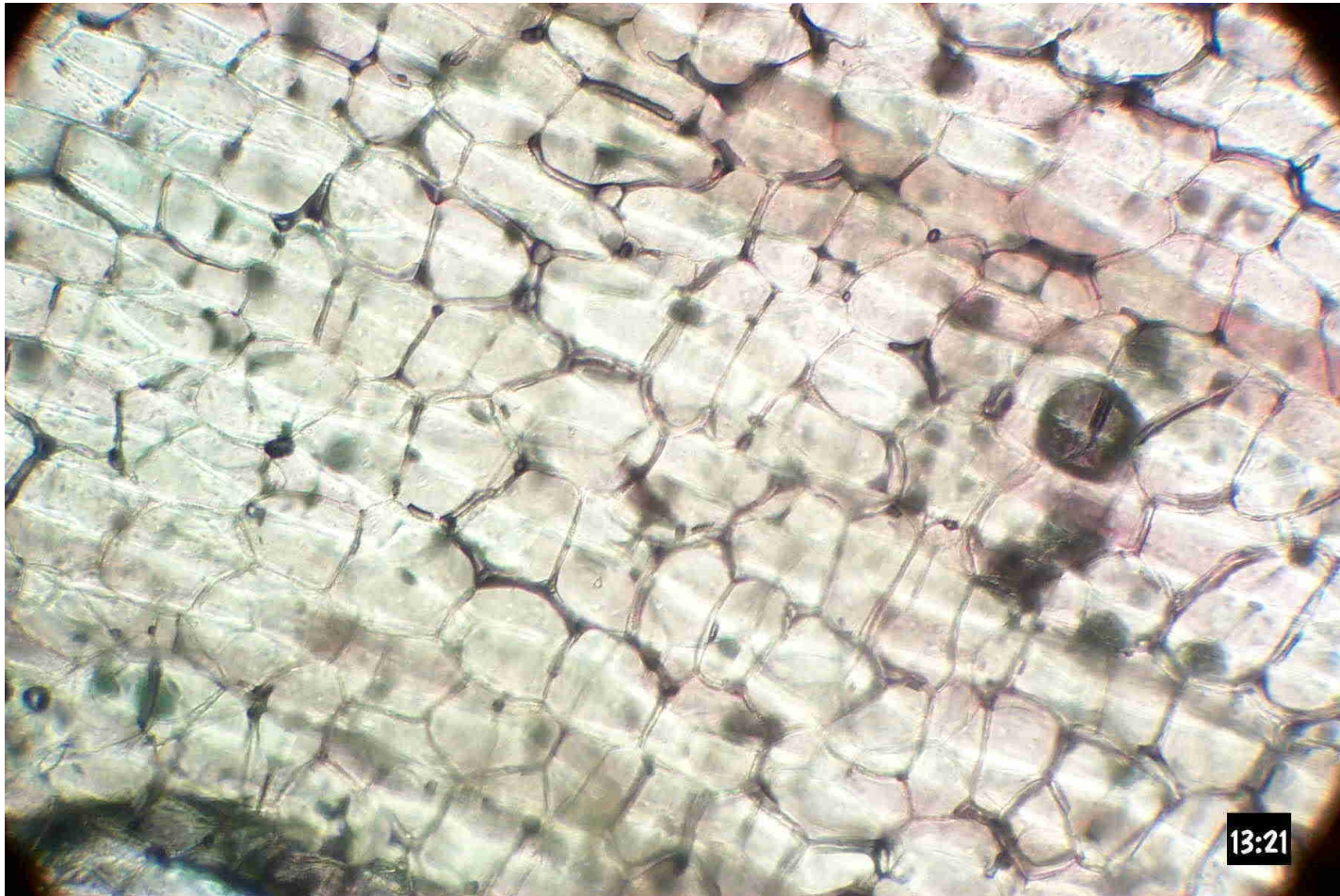
When you whip, it turns white



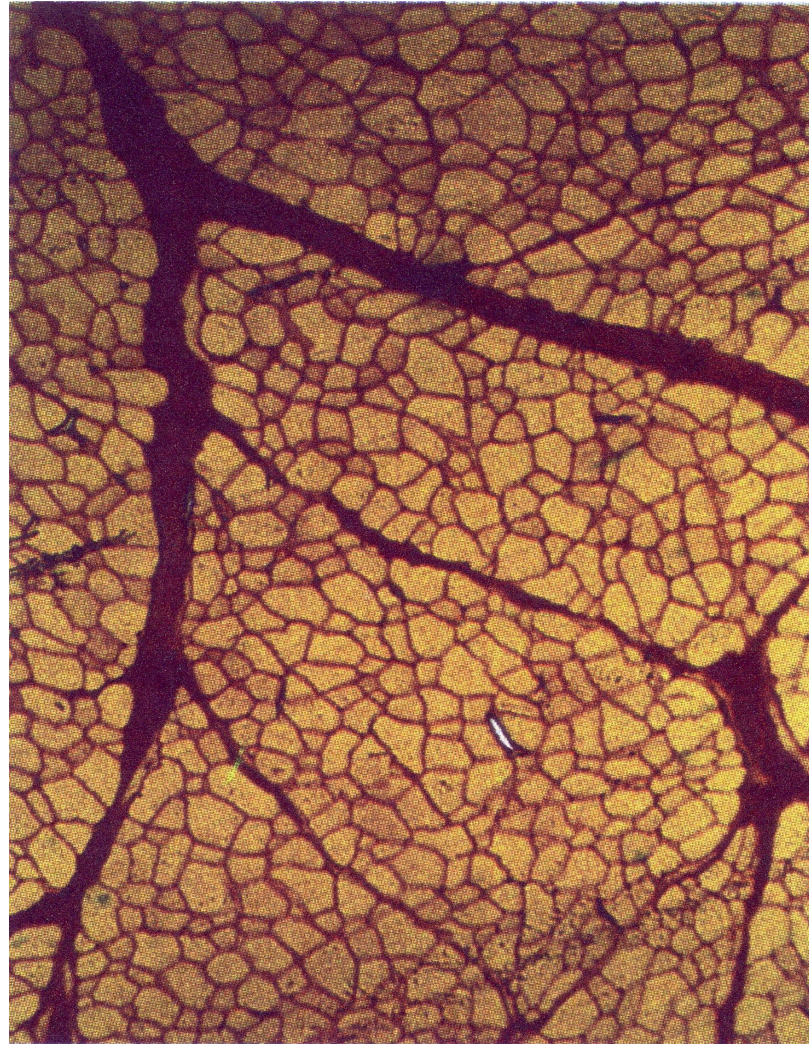
And when you cook, proteins coagulate



Many different gels 1/4 : plant tissue

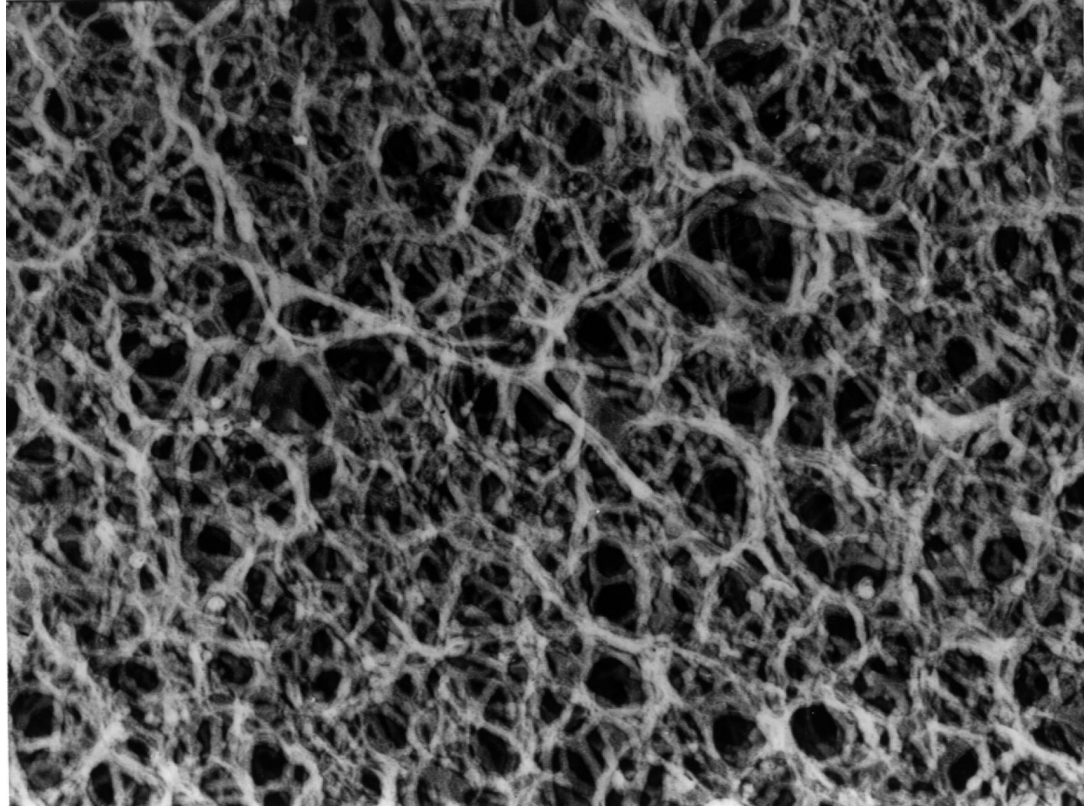


Many different gels 2/4 : meat



Cliché J. Lacour, INRA Theix

Many different gels 3/4 : gelatine



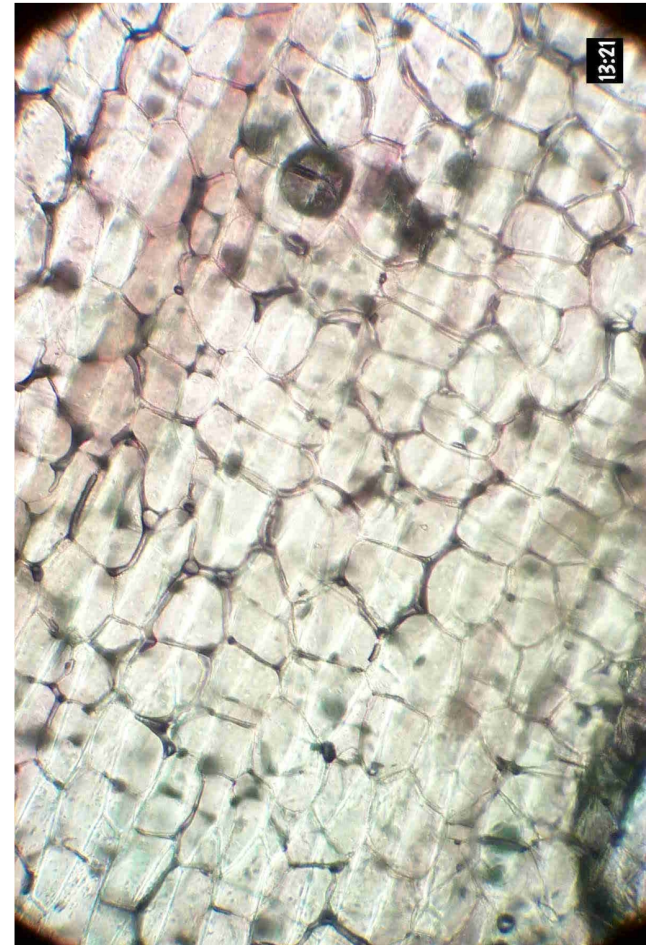
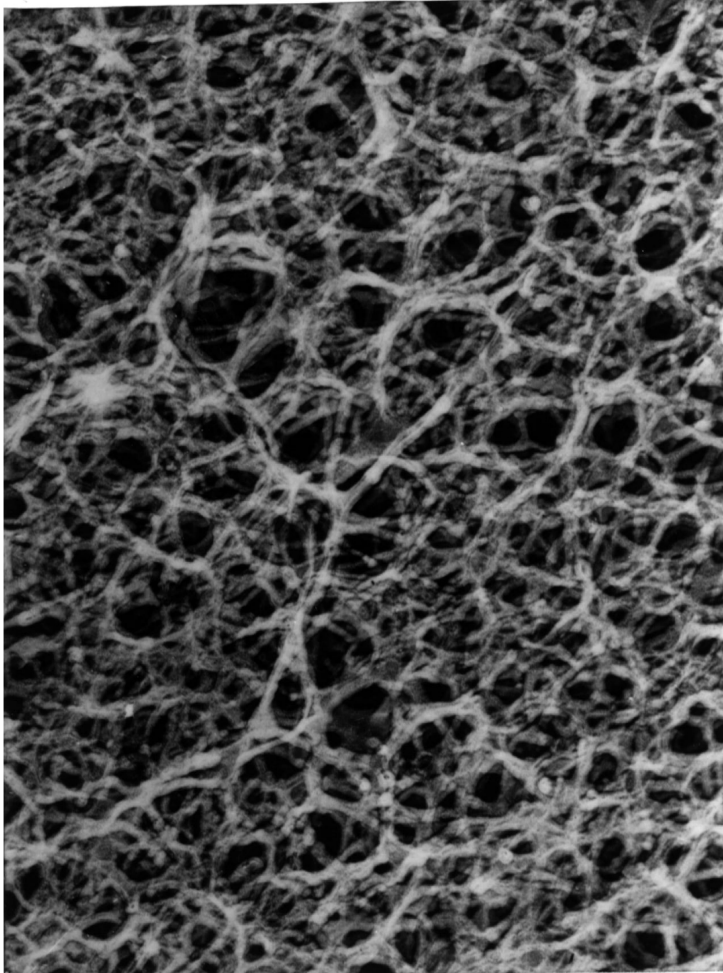
Many different gels 4/4 and 4'4



In some gels, diffusion is possible



How to distinguish gels ?

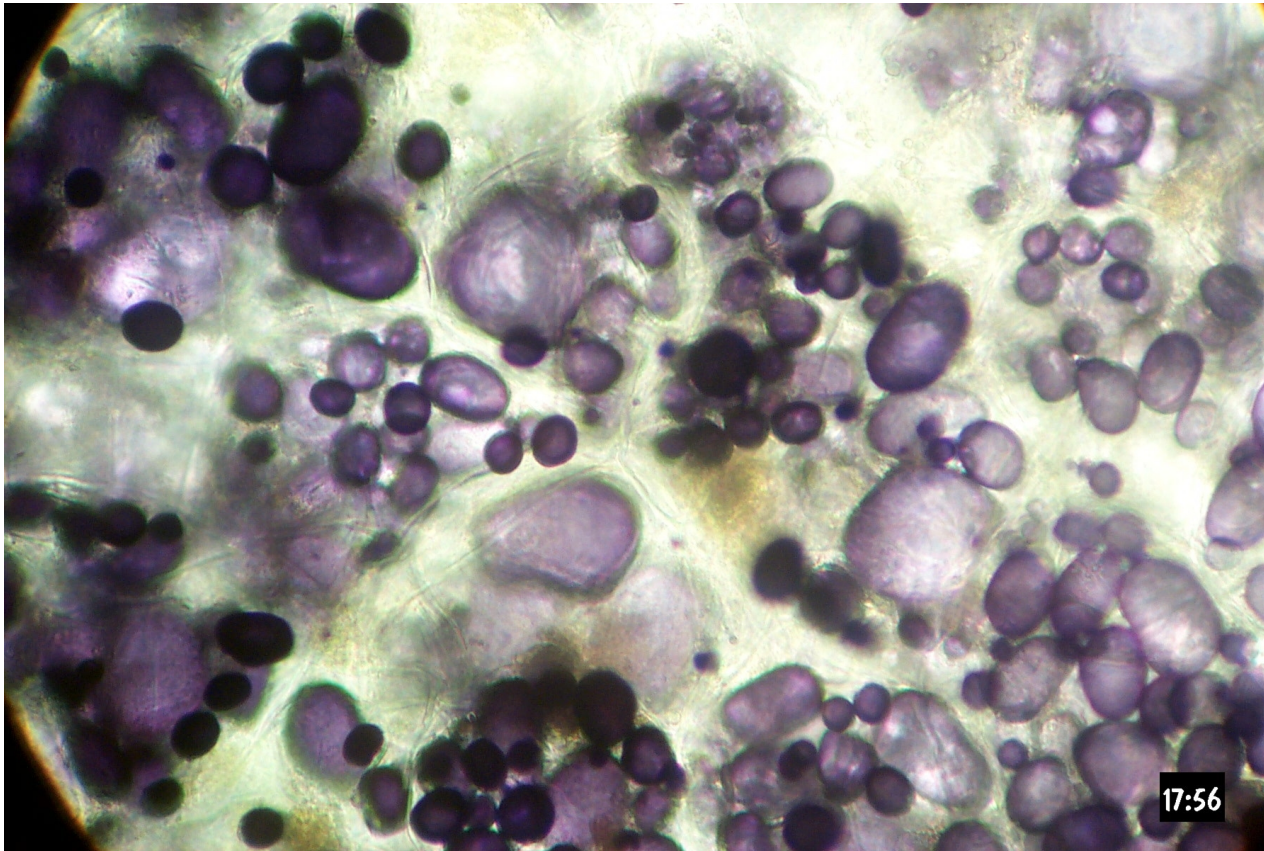


**This description is not enough
because all gels are not of this kind W/S**

Line dispersed in column	Gas	Liquid	Solid
Gas	Gas (not a disperse system)	Liquid aerosol	Solid aerosol
Liquid	Foam	Emulsion	Suspension
Solid	Solid foam	Gel	Solid suspension

How can we describe this one?

Indeed we can't



And this is why this NDSF was introduced

Operators:

- \ : includes a random dispersion of
- + : coexistence of phases, mixture
- $\supset$: inclusion
- σ : superposition (according to x,y,z)
- x : intermixing of two phases

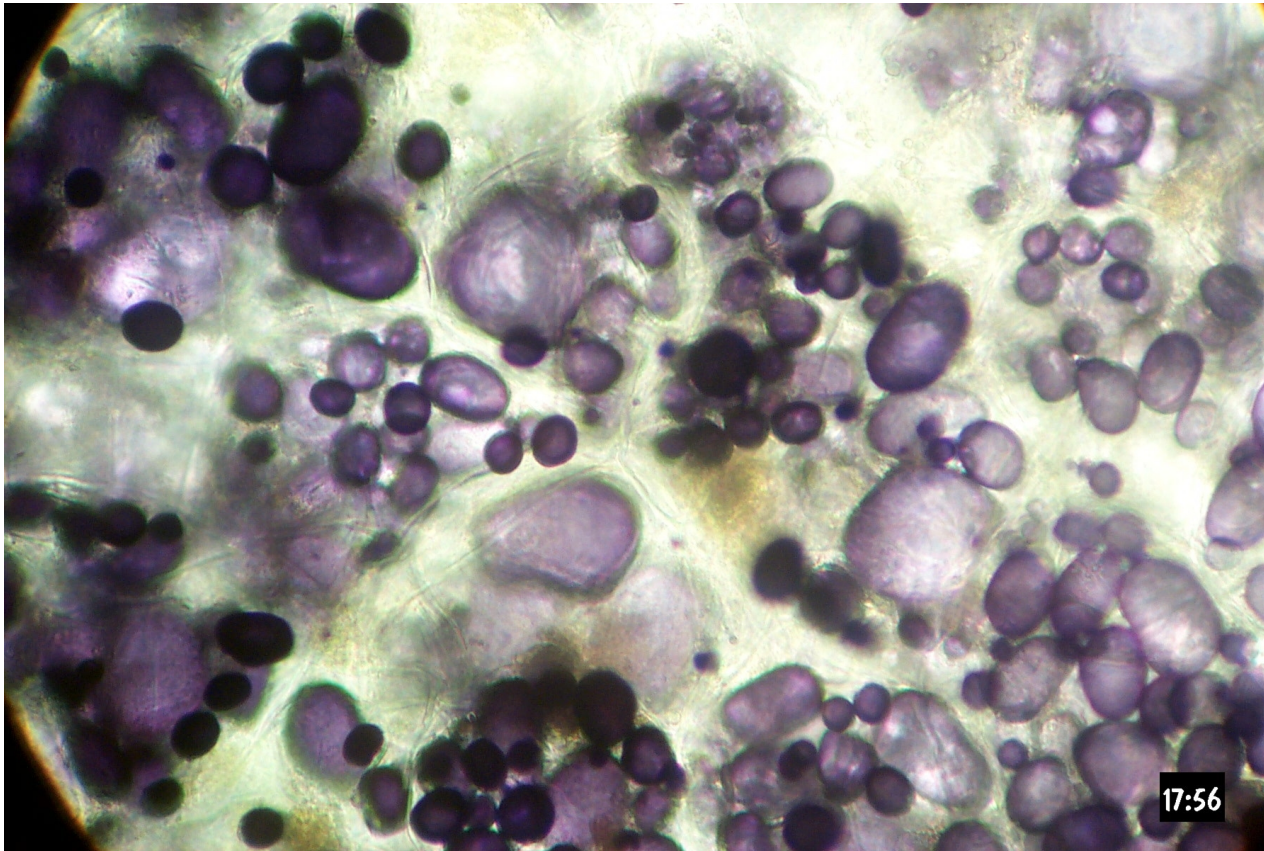
Dimensions

- D0 : dots
- D1: lines
- D2: sheets
- D3: blocks

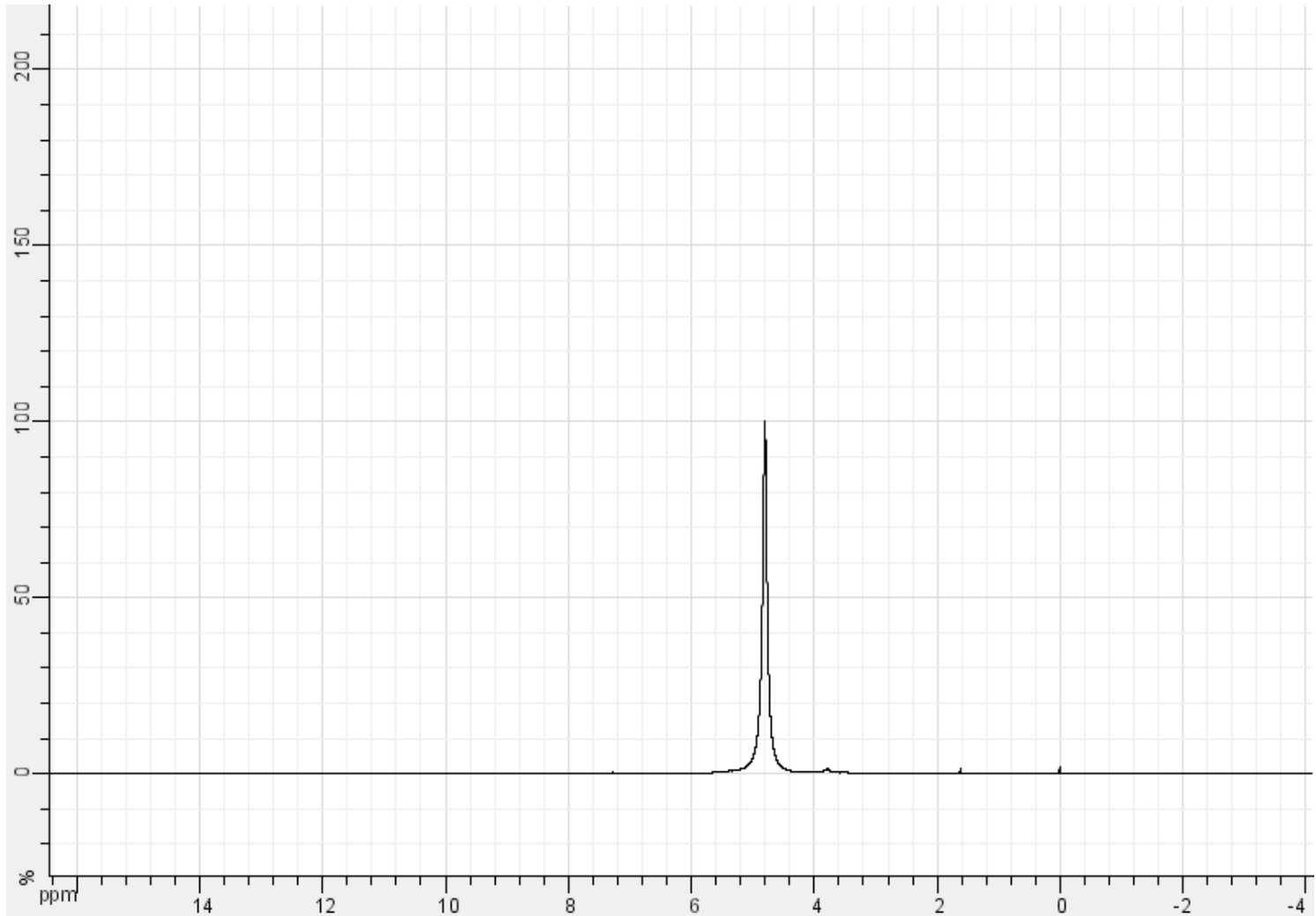
Phases :

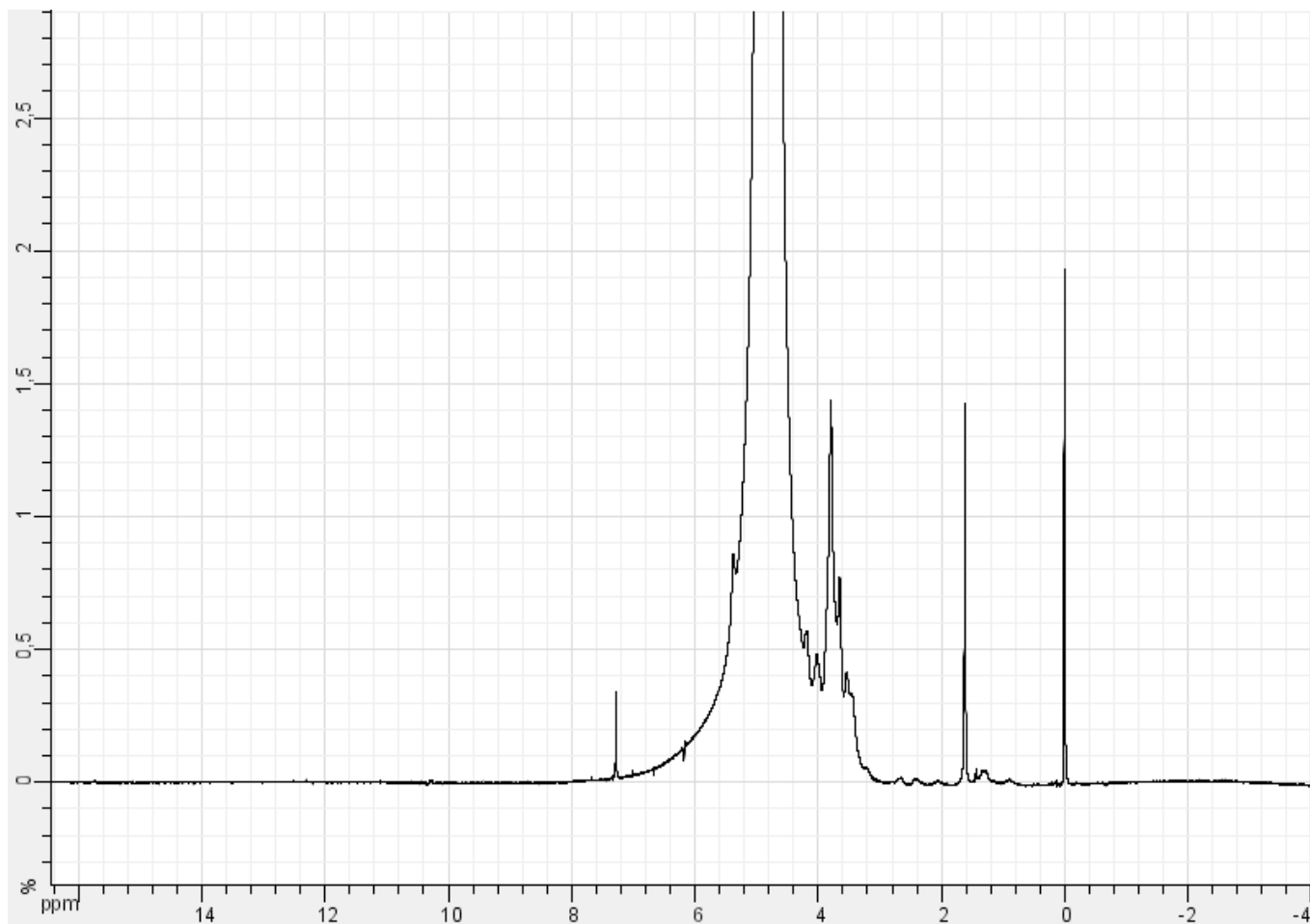
- G : gas
- W : aqueous solutions
- O : oil
- S1, S2, ... : solids

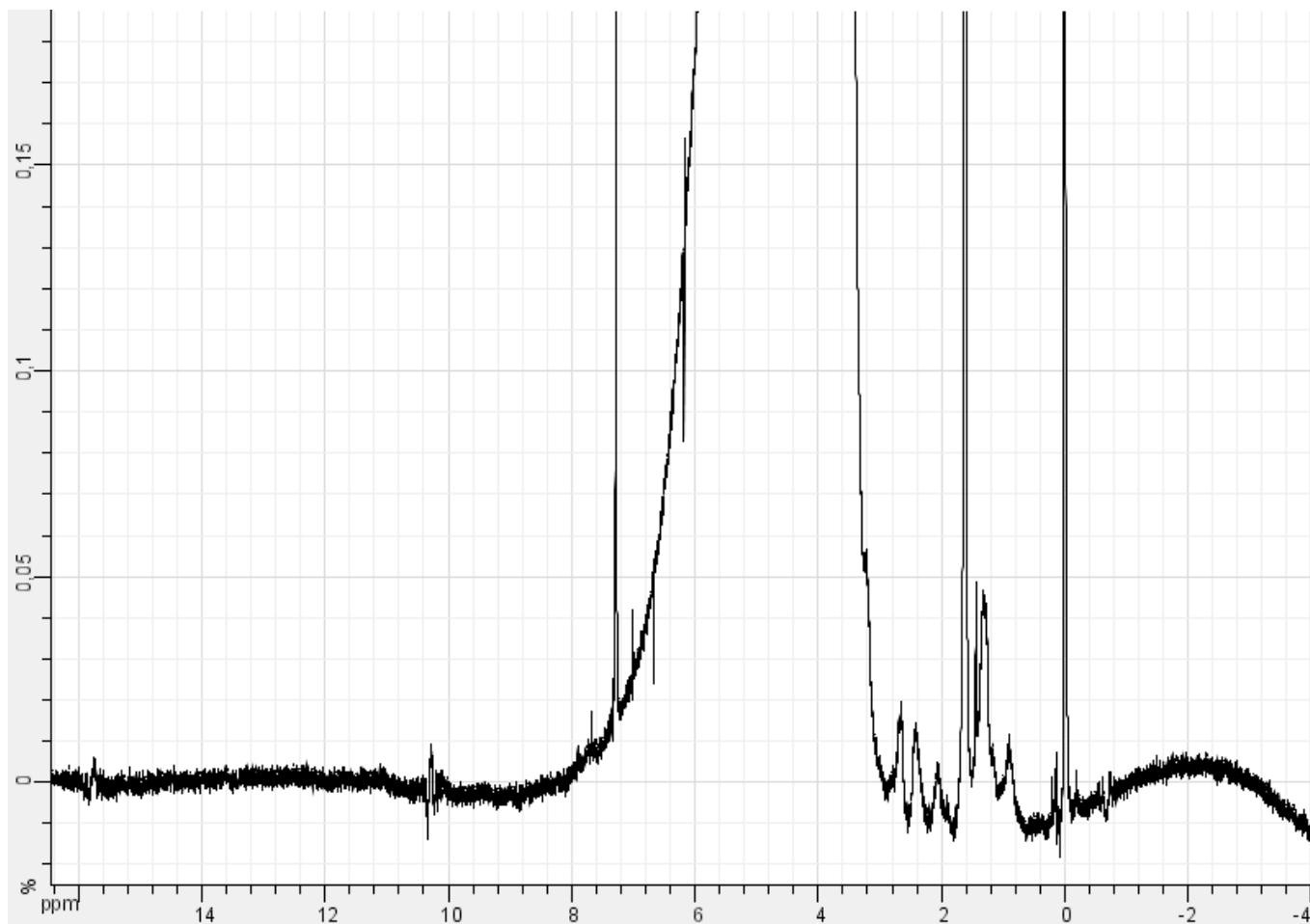
Which scale?



The idea of orders of magnitude

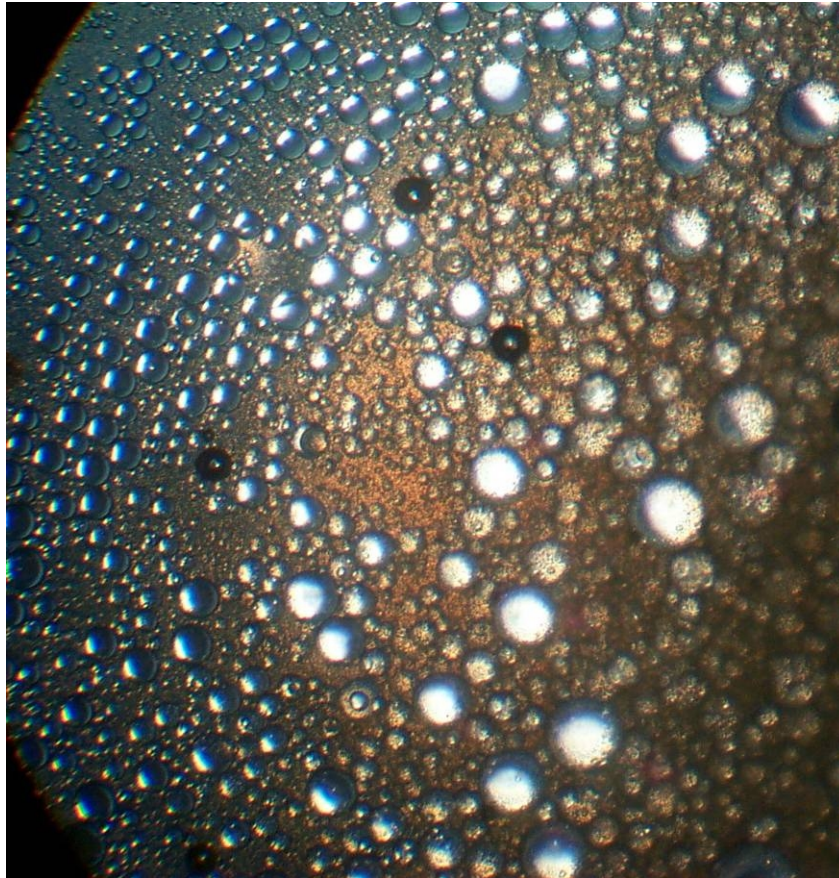






Here, as $10^{-6} < R < 10^{-4}$

Mayonnaise = W \ O



IUPAC Gold Book

emulsion

Online use... ▾



<https://doi.org/10.1351/goldbook.E02065>

A fluid colloidal system in which liquid droplets and/or liquid crystals are dispersed in a liquid. The droplets often exceed the usual limits for colloids in size. An emulsion is denoted by the symbol O/W if the continuous phase is an aqueous solution and by W/O if the continuous phase is an organic liquid (an 'oil'). More complicated emulsions such as O/W/O (i.e. oil droplets contained within aqueous droplets dispersed in a continuous oil phase) are also possible. Photographic emulsions, although colloidal systems, are not emulsions in the sense of this nomenclature.

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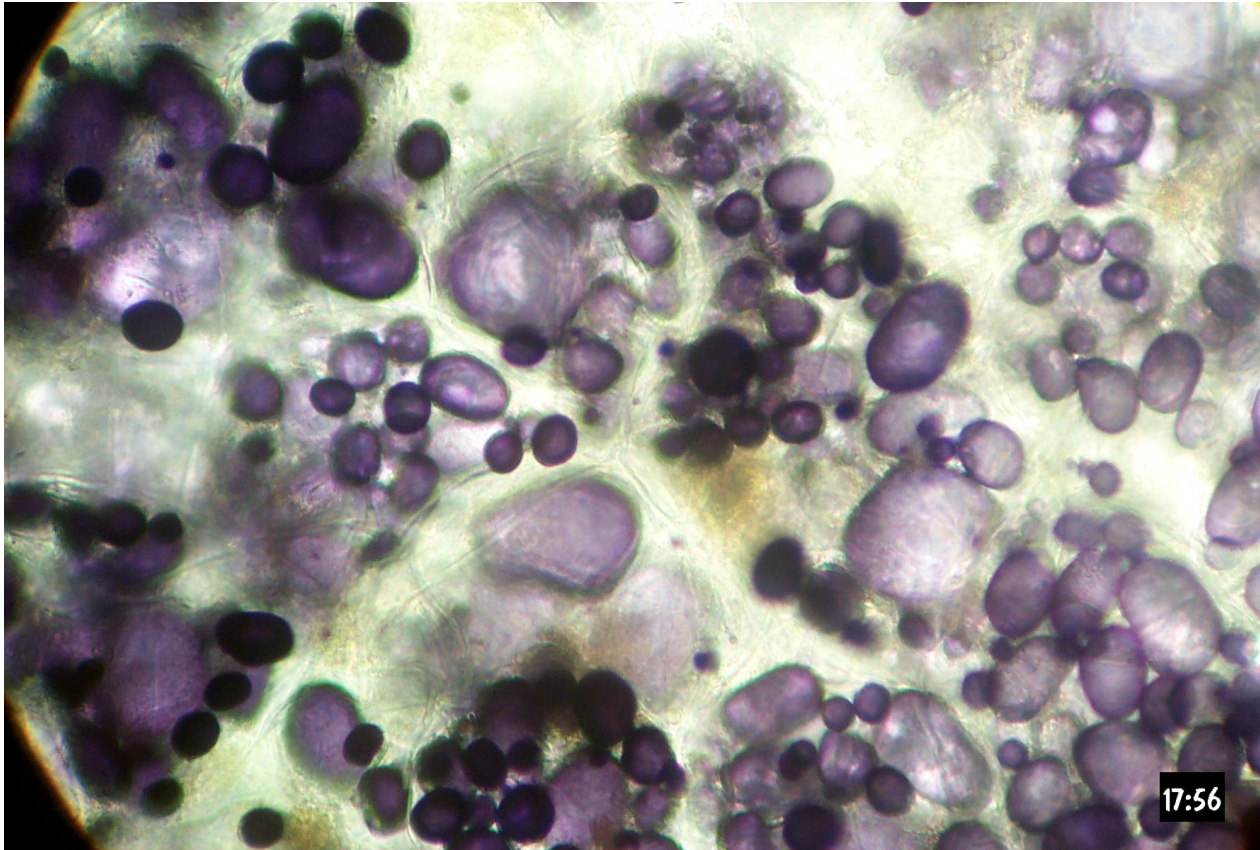
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In the same way ($rs = 10^{-6}$)

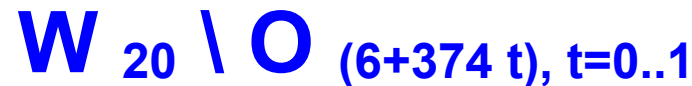
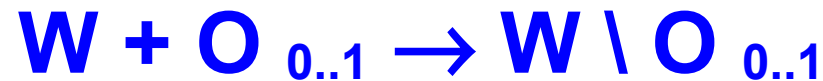
$$\text{Potato} = S_1 \setminus (W \setminus S_2)$$



Adding information and giving precisions (if needed, only if needed)

1. Quantities : A_x ...
2. Scale limits: $[x, y]$
3. Kinetic information : $A_{x(t)}$
4. etc.

With kinetic information



The second part of the description :

Dimensions

- D_0 :
- object of dimension 0,
- Dots:



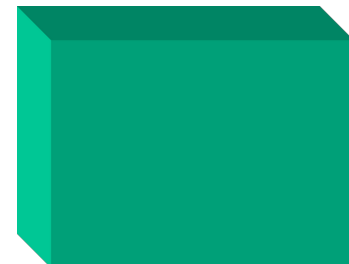
- D_1 :
- Objects of dimension 1,
- lines :



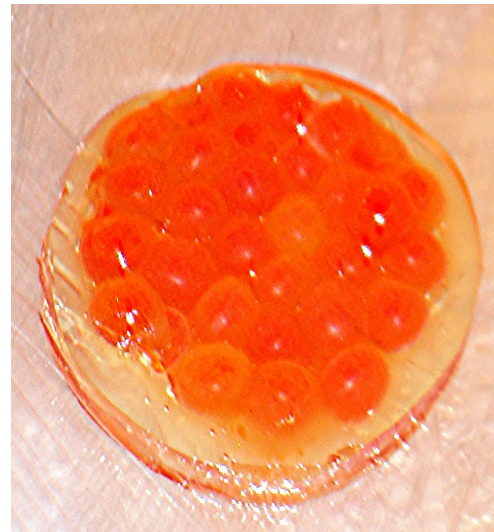
- D_2 :
- Objects of dimension 2,
- Plane, sheets :



- D_3 :
- Objects of dimension 3,
- cubes :



Mixing dimensions and phases



$$D_3 \setminus (D_1(S_1 \setminus W_1) \supset (D_1(S_2 \setminus W_2)))$$

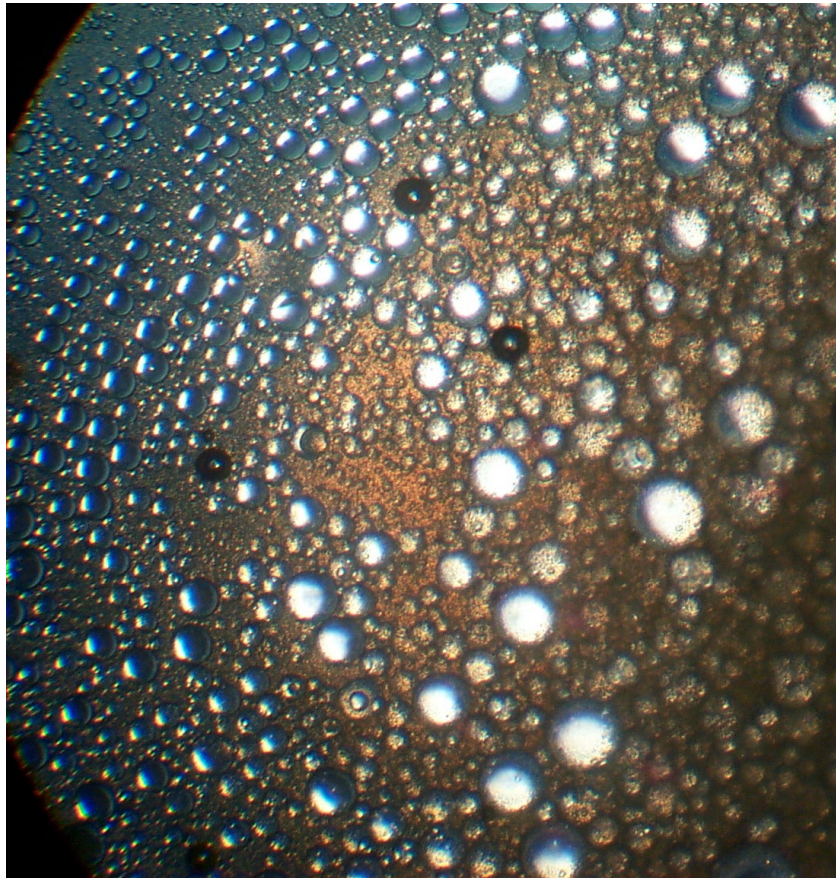
$$D_2(S_1 \setminus W_1) \setminus D_0(S_2 \setminus W_2) \supset D_0(W_3)$$

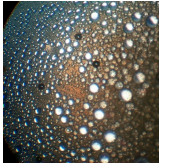
$$D_3 \setminus D_1(S)$$

$D_2(L) \sigma D_3(S_1) \sigma D_3(S_2) \sigma D_2(S_3) \sigma D_2(L)$

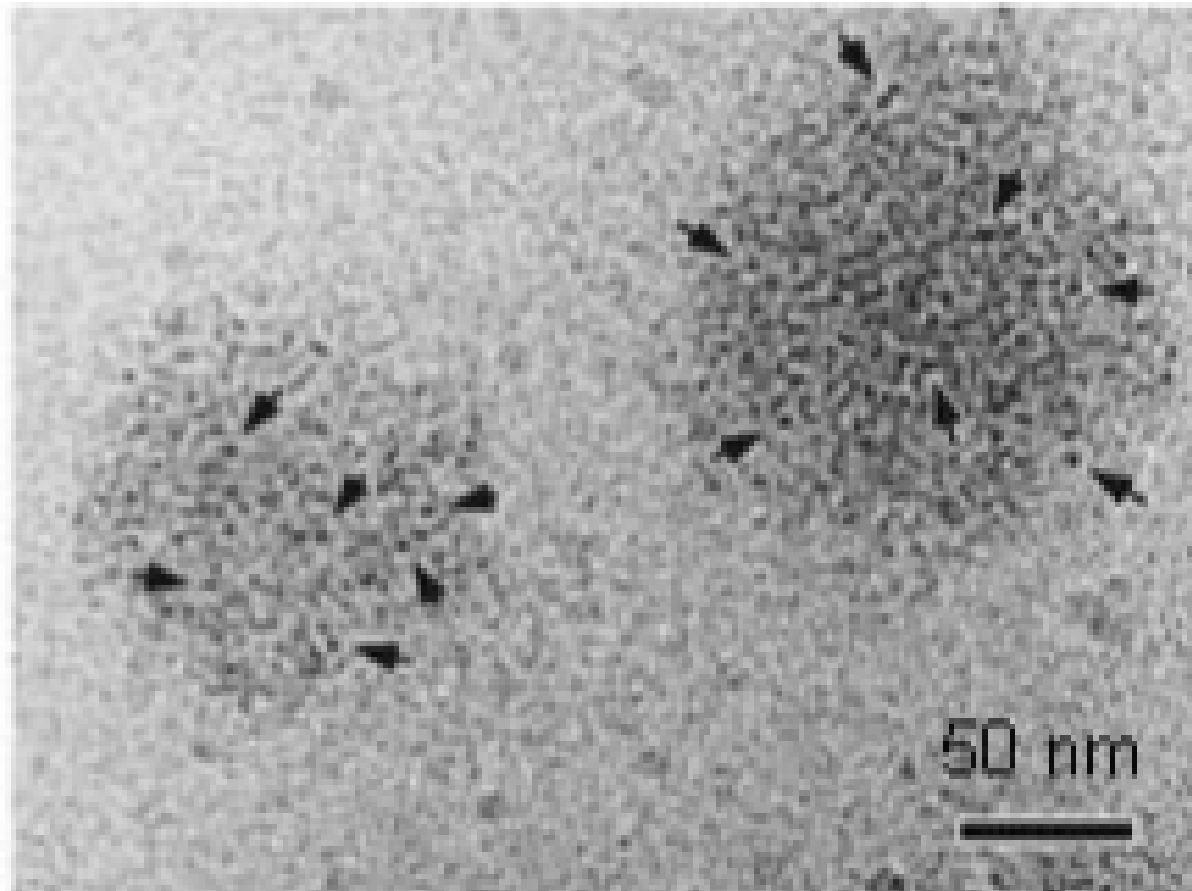


$$D_3(W) \setminus D_0(O)$$

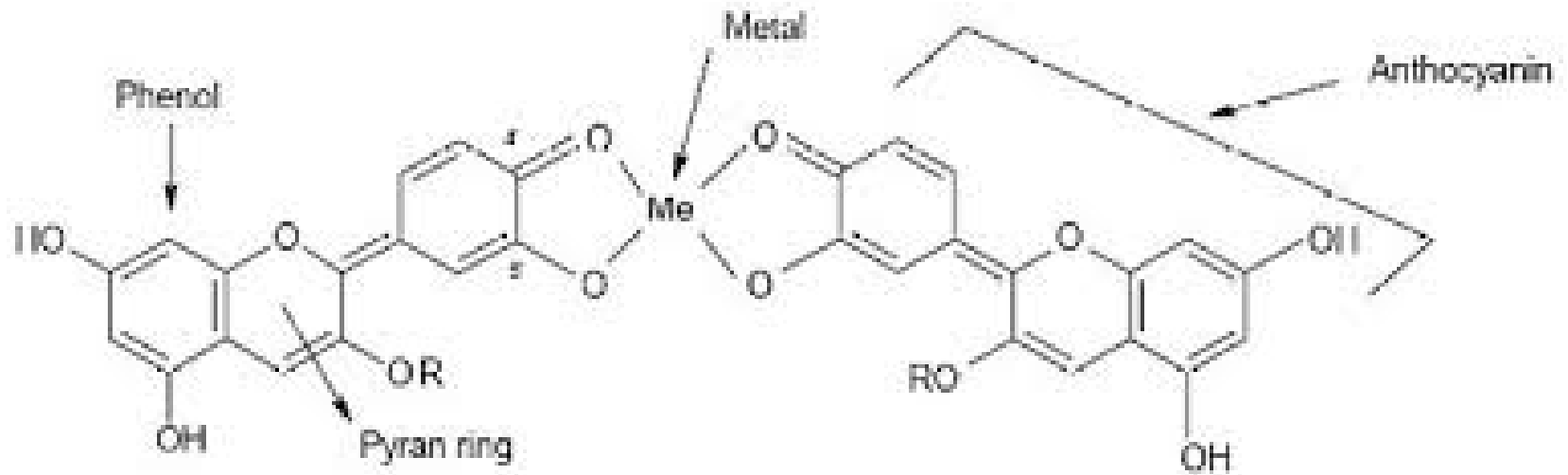
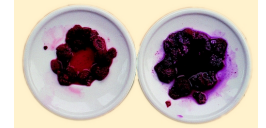




$$D_3(W) \setminus [D_0(S_1) \times D_0(W)]$$

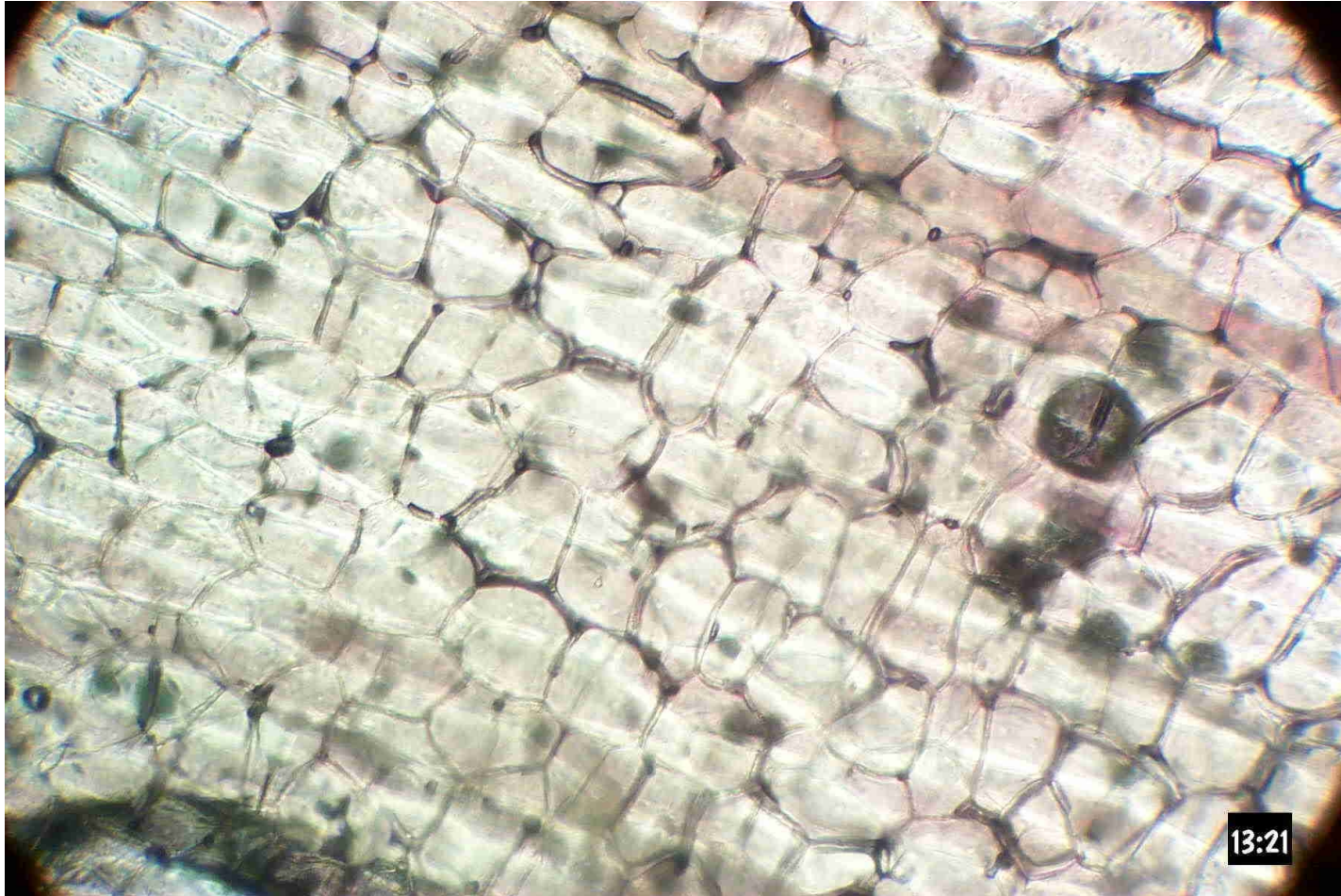


$D_3(\text{Me}) \sigma D_3(\text{PPh})$



Remember : gels

$D_3(S) \setminus D_0(W)$

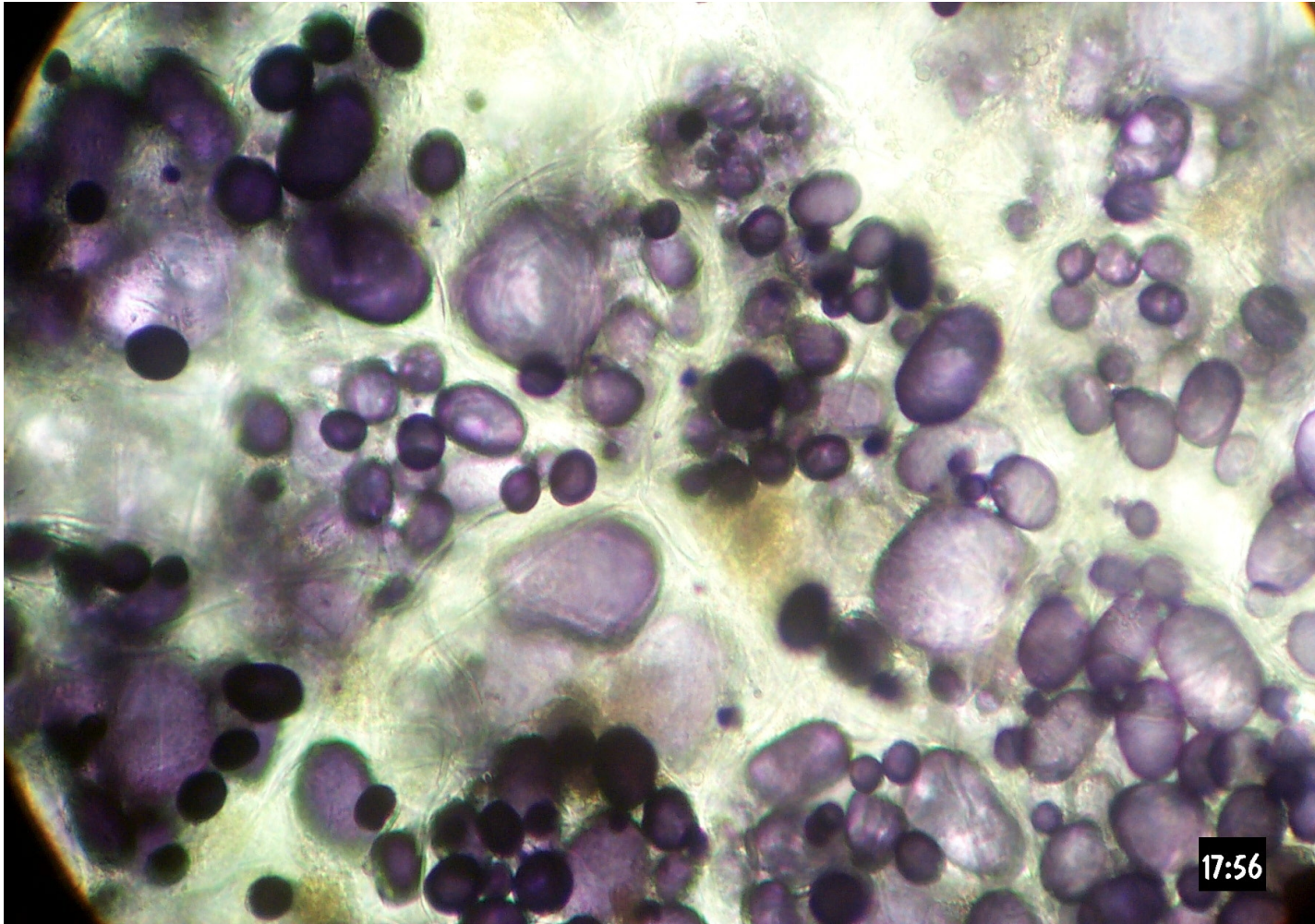


Hence artificial gels

$$D_2(S) \setminus D_0(W)$$

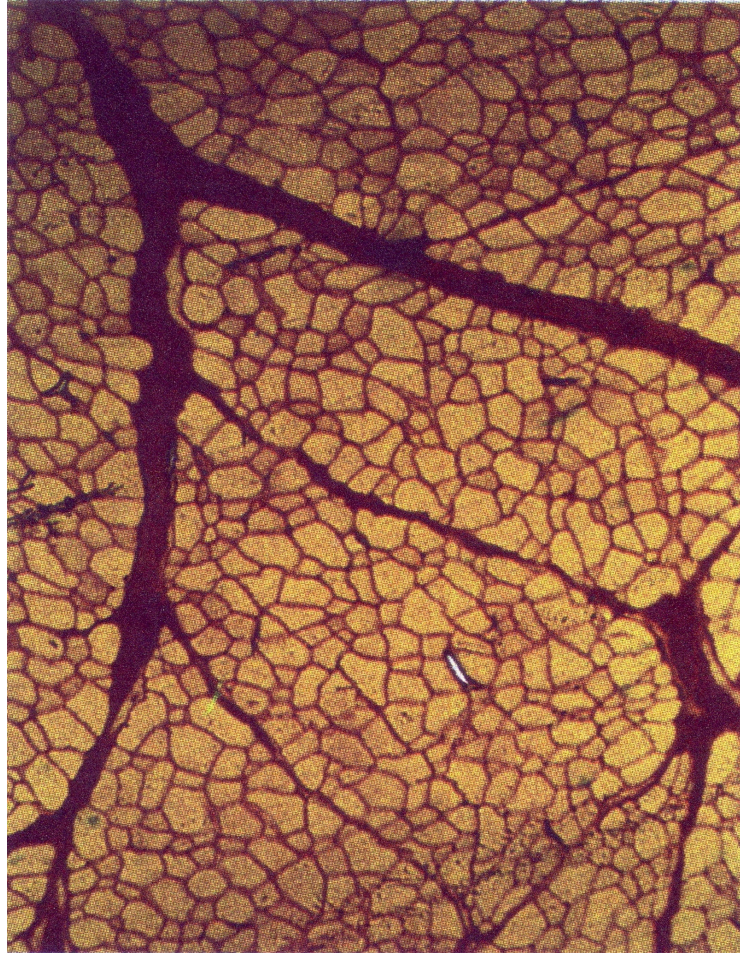

Sometimes, complex gels :

$$D_3(S_1) \setminus [D_0(W) \setminus D_0(S_2)]$$



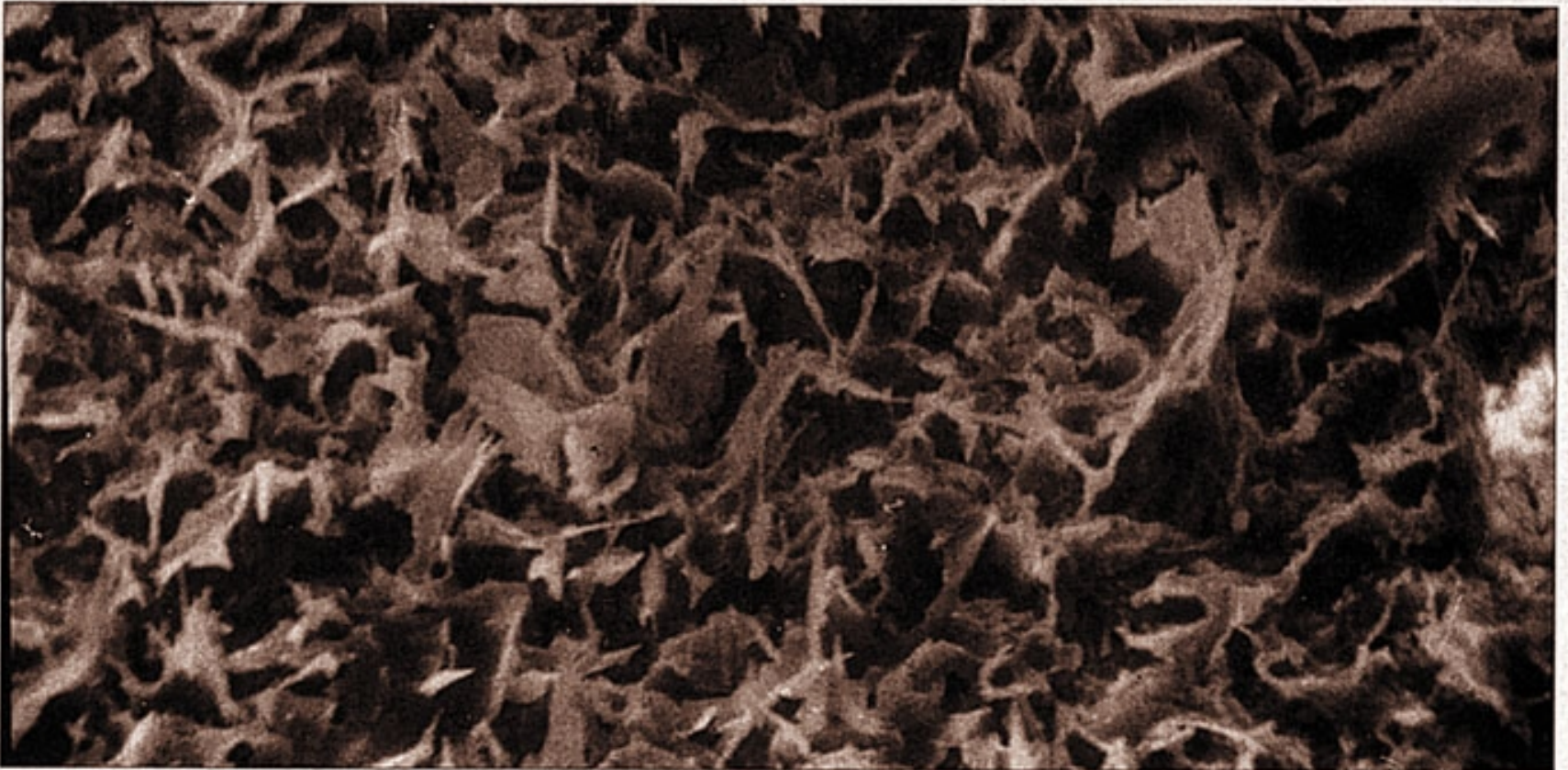
Sometimes anisotropy

$$D_3(S) \setminus D_1(W)$$



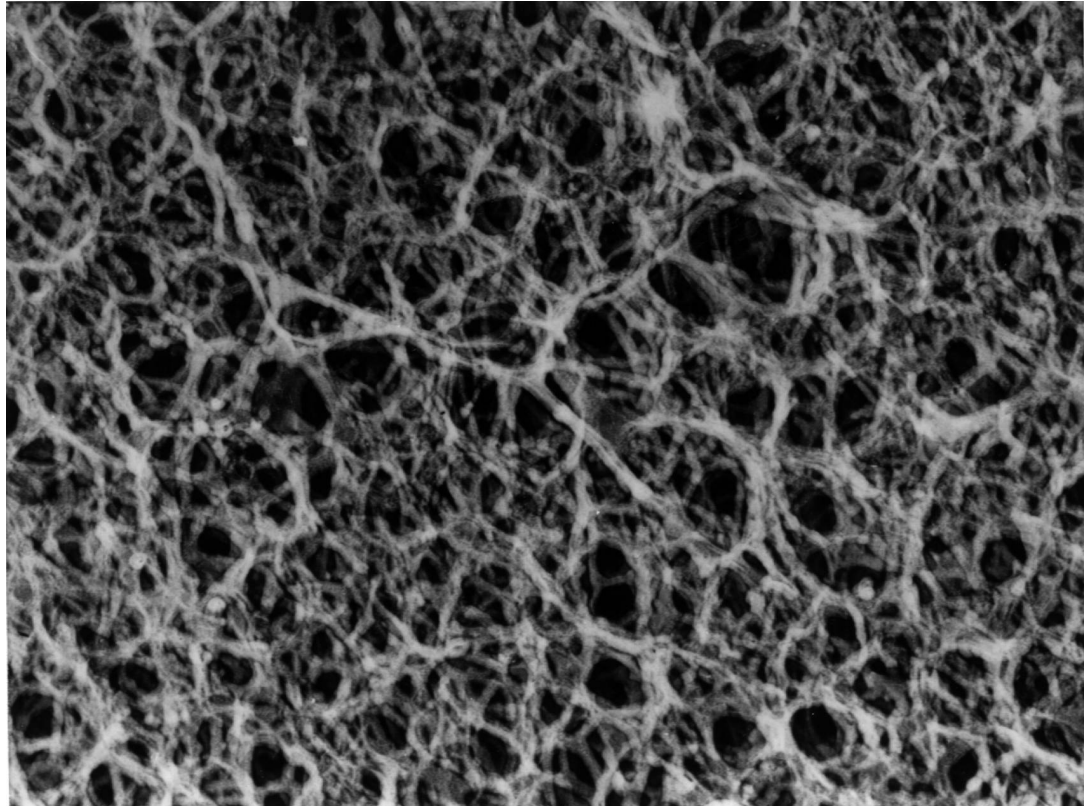
**Sometimes, the gels were not
recognized as such**

$$\mathbf{D_3(S) \times D_3(O)}$$

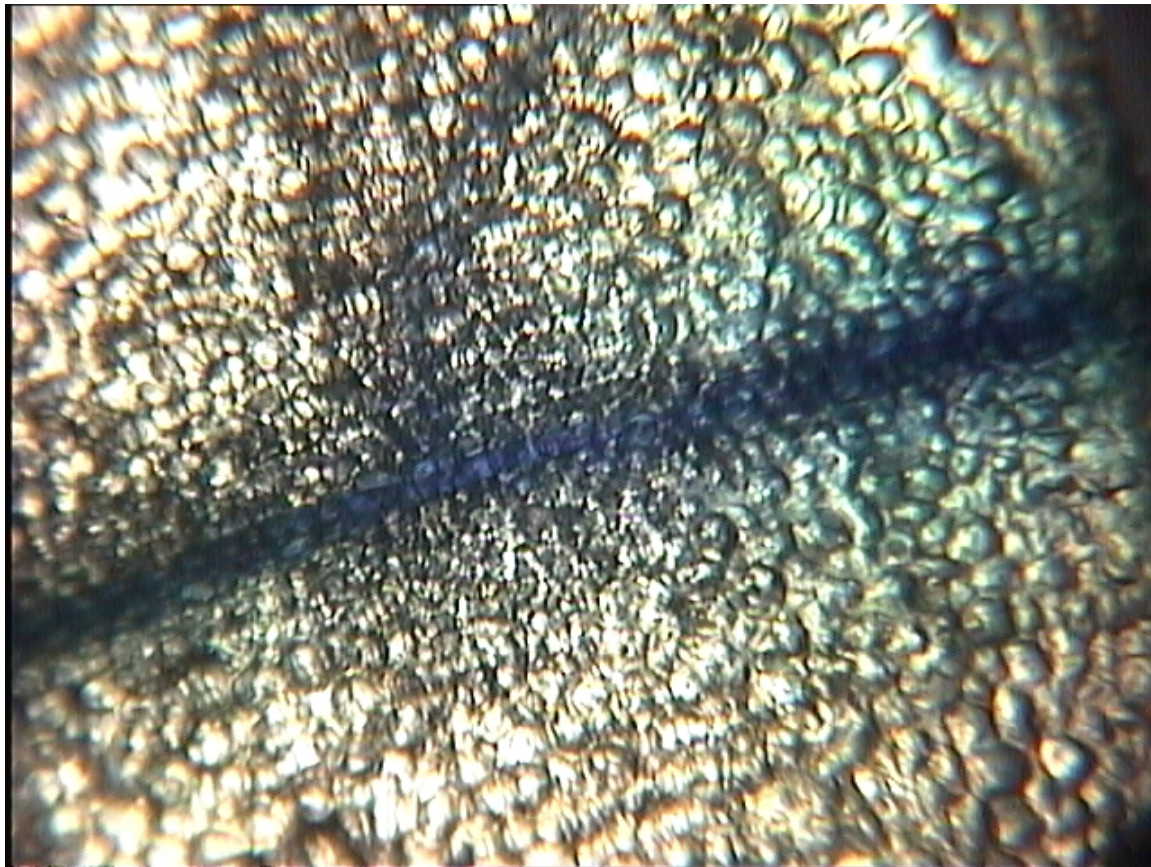


Sometimes, diffusion is possible

$$D_3(S) \times D_3(W)$$



Complex gels are an invitation to do more:

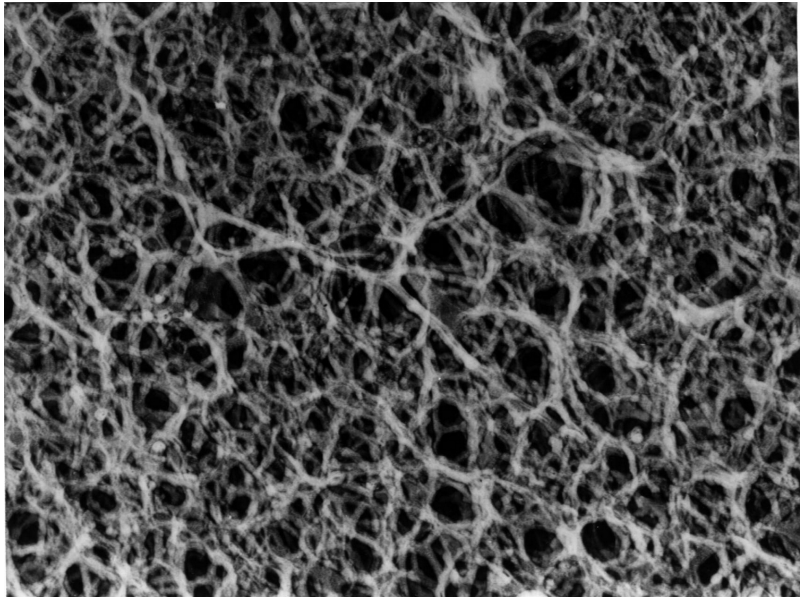
$$D_3(S) \setminus [D_0(W) + D_1(W)]$$


Fibrés, artificial meats :

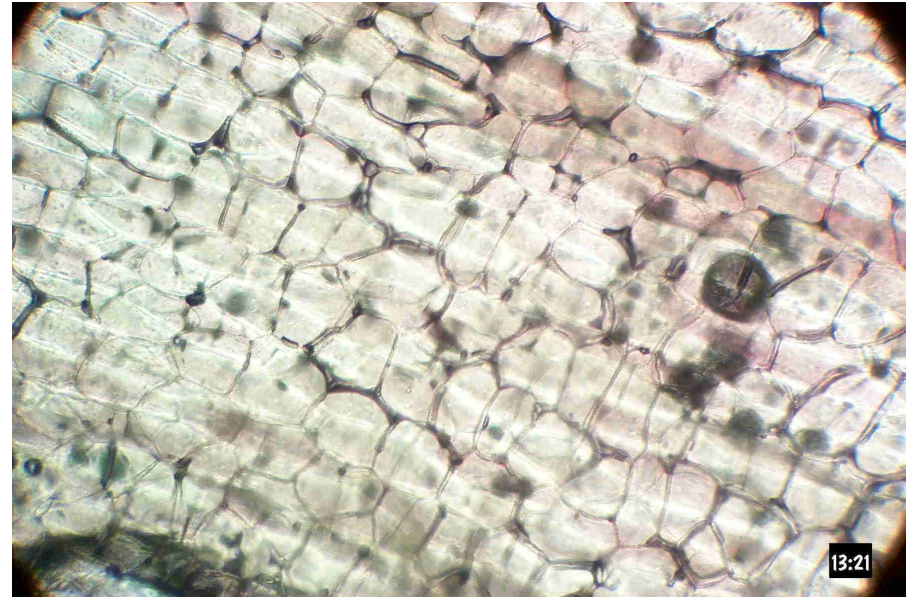
$$D_3(S_1) \setminus [D_1(S_2) \supset D_1(S_3 \times W)]$$



Now, gels can be distinguished

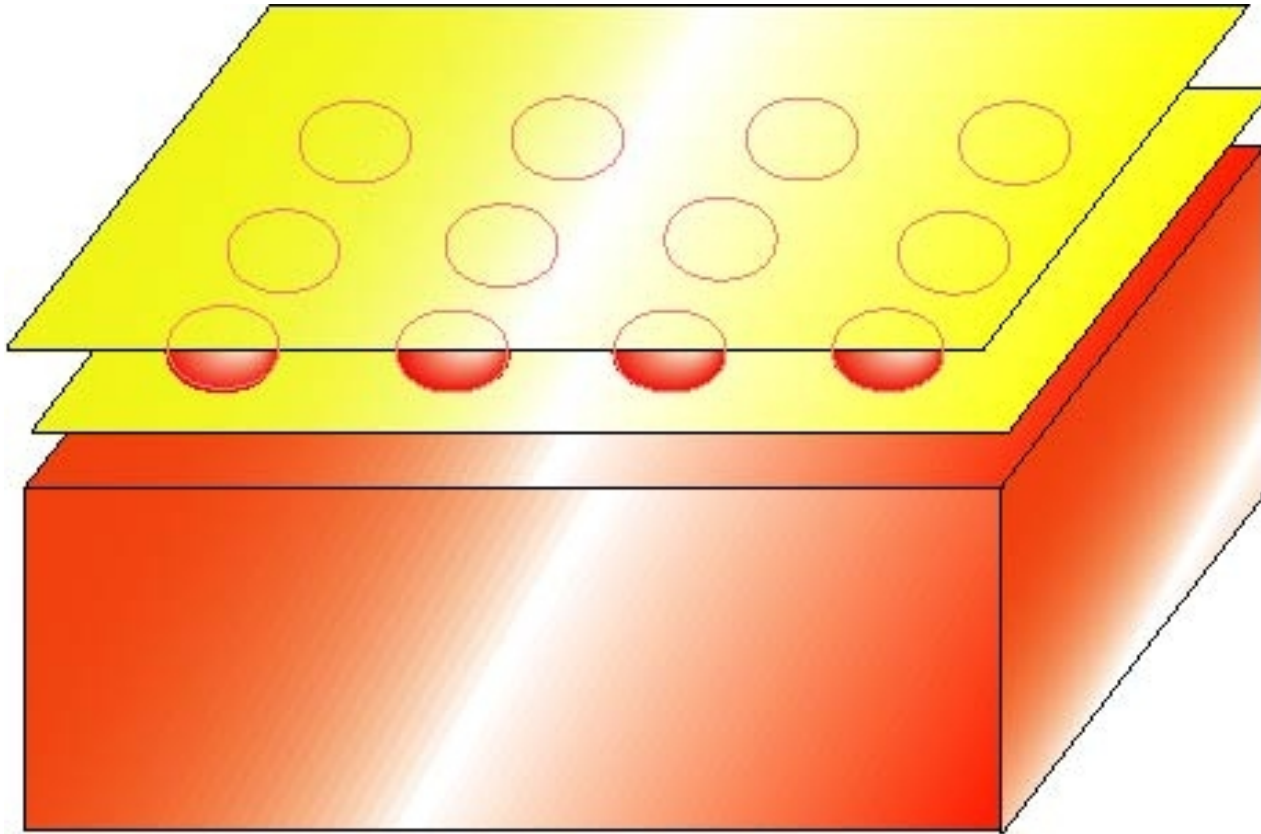


$$D_3(S) \times D_3(W)$$



$$D_3(S) \setminus D_0(W)$$

An infinite number of possibilities



$$D_2 \sigma_z [[(D_1 \sigma_x D_1)^{4\sigma_x}] \sigma_y [(D_1 \sigma_x D_1)^{4\sigma_x}]^{4\sigma_y}] \sigma_z D_2 \sigma_z D_3$$

In honor of Michael Faraday



One dish among one infinity

- Let's choose one formula:
- **$S_1 \setminus [W \setminus (G+O+S_2)]$**
- And let's decide for a lobster dish

Faraday of lobster

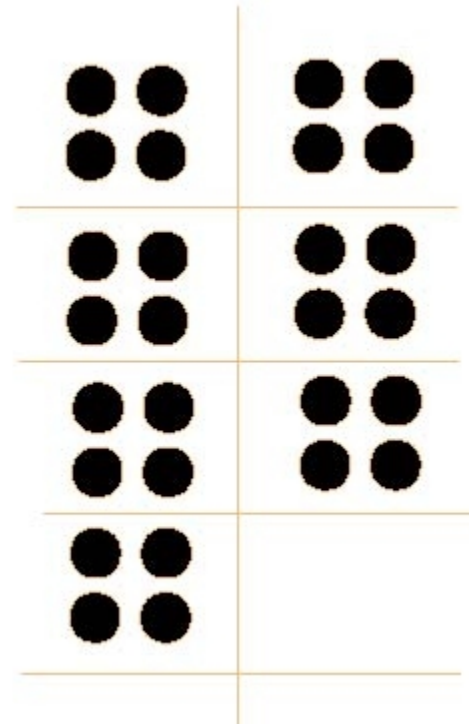
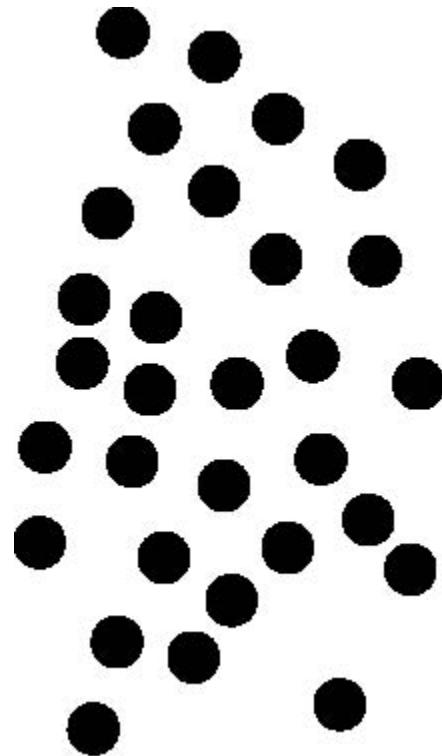
$S_1 \setminus [W \setminus (G+O+S_2)]$



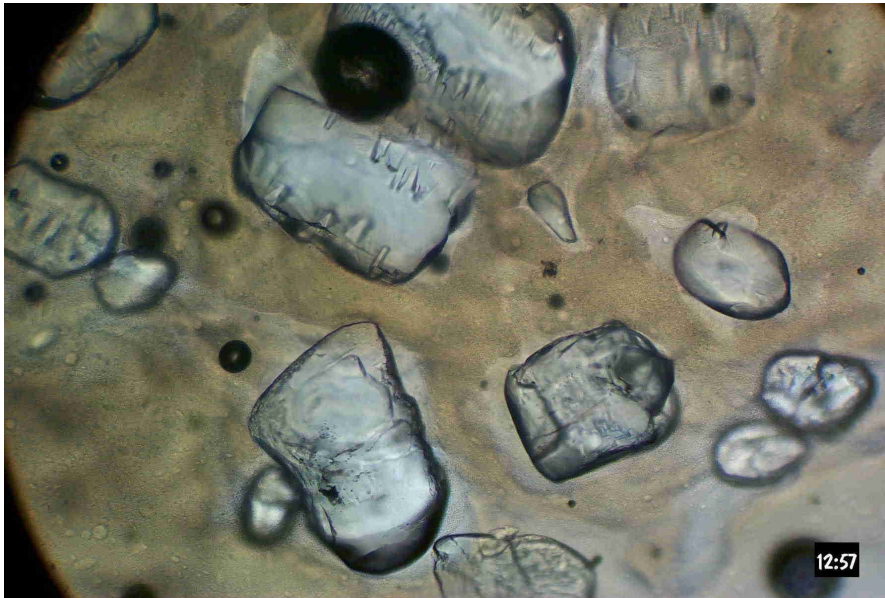
How to organize such a mess

- Fonds brun, Fonds blanc, Fonds de volaille, Fonds de gibier, Fonds, ou fumet de poisson, Fonds de poisson au vin rouge, Essence de poisson, Essences diverses, Glaces diverses, Glace de viande, Glace de volaille, Glace de gibier, Glace de poisson, Roux brun, Roux blond, Roux blanc, Sauce espagnole, Sauce espagnole maigre, Sauce demi-glace, Jus de veau lié, Velouté, ou sauce blanche grasse, Velouté de volaille, Velouté de poisson, Sauce parisienne, Sauce suprême, Sauce béchamel, Petites sauces brunes composées, Sauce bigarade, Sauce bordelaise, Sauce bourguignonne, Sauce bretonne, Sauce aux cerises, Sauce aux champignons, Sauce charcutière, Sauce chasseur, Sauce chaud-froid brune, Sauce chaud-froid pour canards, Sauce chaud-froid pour gibier, Sauce chaud-froid tomate, Sauce chevreuil, Sauce Colbert, Sauce diable, Sauce Diane, Sauce duxelles, Sauce estragon, Sauce financière, Sauce aux fines herbes, Sauce genevoise, Sauce Godart, Sauce grand-veneur, Sauce gratin, Sauce hachée, Sauce hachée maigre, Sauce hussarde, Sauce italienne, Jus lié à l'estragon, Jus lié tomate, Sauce lyonnaise, Sauce Madère, Sauce matelote, Sauce moelle, Sauce moscovite, Sauce Périgueux, Sauce périgourdine, Sauce piquante, Sauce poivrée ordinaire, Sauce poivrée pour gibier, Sauce au Porto, Sauce portugaise, Sauce provençale, Sauce régence, Sauce Robert, Sauce romaine, Sauce rouennaise, Sauce salmis, Sauce tortue, Sauce venaison, Sauce au vin rouge, Sauce zingara, Petites sauces blanches, composées et de réductions, Sauce Albuféra, Sauce américaine, Sauce anchois, Sauce Aurore, Sauce Aurore maigre, Sauce bavaise, Sauce béarnaise, Sauce béarnaise tomate, dite sauce Choron, Sauce béarnaise à la glace de viande, dite Sauce Foyot ou Sauce Valois, Sauce Bercy, Sauce au beurre, dite Sauce bâtarde, Sauce Bonnefoy, ou Sauce bordelaise au vin blanc, Sauce bretonne, Sauce canotière, Sauce aux câpres, Sauce cardinal, Sauce aux champignons, Sauce Chantilly, Sauce Chateaubriand, Sauce chaud-froid blanche ordinaire, Sauce chaud-froid blonde, Sauce chaud-froid Aurore, Sauce chaud-froid au vert-pré, Sauce chaud-froid maigre, Sauce Chivry, Sauce à la crème, Sauce aux crevettes, Sauce currie, Sauce currie à l'Indienne, Sauce diplomate, Sauce écossaise, Sauce estragon, Sauce aux fines herbes, Sauce groseilles, Sauce hollandaise, Sauce homard, Sauce hongroise, Sauce aux huîtres, Sauce indienne, Sauce ivoire, Sauce Joinville, Sauce Laguipierre, Sauce livonienne, Sauce maltaise, Sauce marinière, Sauce matelote blanche, Sauce Mornay, Sauce mousseline, dite Sauce Chantilly, Sauce mousseuse, Sauce moutarde, Sauce Nantua, Sauce New-burg avec le homard cru, Sauce New-burg avec le homard cuit, Sauce noisette, Sauce normande, Sauce orientale, Sauce paloise, Sauce poulet, Sauce ravigote, Sauce régence pour poissons et garnitures de poissons, Sauce régence pour garnitures de volailles, Sauce riche, Sauce Rubens, Sauce Saint-Malo, Sauce smitane, Sauce Solférino, Sauce Soubise, ou Coulis d'oignon Soubise, Sauce Soubise tomate, Sauce Souchet, Sauce tyrolienne, Sauce tyrolienne à l'ancienne, Sauce Valois, Sauce vénitienne, Sauce Véron, Sauce villageoise, Sauce Villeroy, Sauce Villeroy soubisée, Sauce Villeroy tomate, Sauce vin blanc, Sauces anglaises chaudes, Sauce aux aïelles, Sauce Albert, Sauce aux aromates, Sauces au beurre à l'anglaise, Sauce aux câpres, Sauce au céleri, Sauce au chevreuil, Sauce crème à l'anglaise, Sauce crevettes à l'anglaise, Sauce diable, Sauce écossaise, Sauce au fenouil, Sauce aux groseilles, Sauce homard à l'anglaise, Sauce aux huîtres, Sauce brune aux huîtres, Sauce aux oeufs à l'anglaise, Sauce aux oeufs au beurre fondu, Sauce aux oignons, Sauce au pain, Sauce au pain frit, Sauce persil, Sauce persil pour poissons, Sauce aux pommes, Sauce au Porto, Sauce au raifort chaude, Sauce Réforme, Sauce sauge et oignons, Sauce Yorkshire, Sauces froides, Sauce aioli, ou Beurre de Provence, Sauce andalouse, Sauce bohémienne, Sauce Chantilly, Sauce génoise, Sauce gribiche, Sauce groseille au raifort, Sauce italienne, Sauce mayonnaise, Sauce mayonnaise collée, Sauce mayonnaise fouettée, à la Russe, Sauces mayonnaises diverses, Sauce mousquetaire, Sauce moutarde à la crème, Sauce raifort aux noix, Sauce ravigote, ou Vinaigrette, Sauce rémoulade, Sauce russe, Sauce tartare, Sauce verte, Sauce Vincent, Sauce suédoise, Sauces froides anglaises, Sauce Cambridge, Sauce Cumberland, Sauce Gloucester, Sauce menthe, Sauce Oxford, Sauce raifort

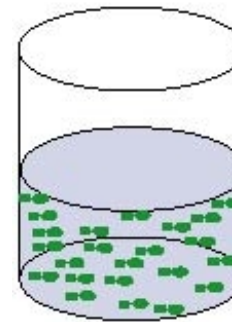
Looking for laws



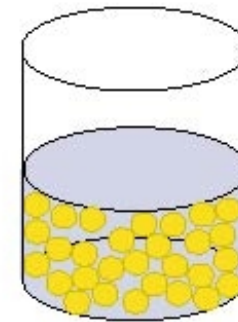
Simple sauces



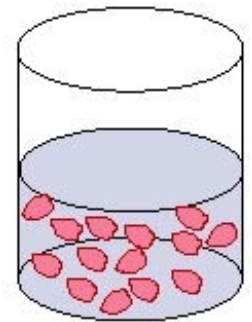
1. Systèmes simples



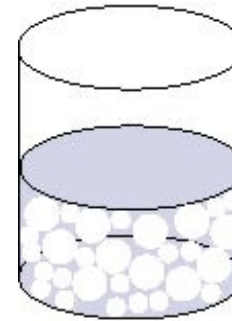
Solution E



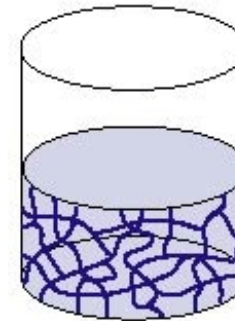
Emulsion H/E
(mayonnaise...)



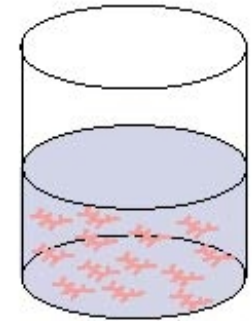
Suspension S/E
(civet, crème anglaise...)



Mousse G/E

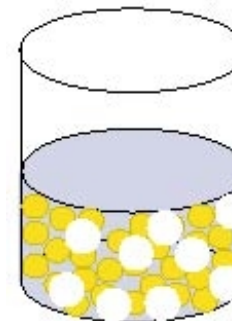


Gel E/S

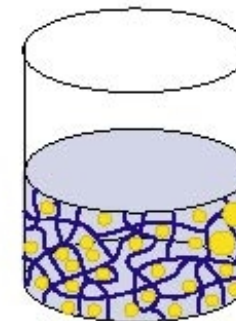


Hydrocolloïdes E

2. Systèmes complexes



Emulsion
mousseuse
(G+H)/E



Emulsion gélifiée
(E+H)/S

etc.



The corpus : 451 sauces

Name	Minimum culinary recipe	Derived from	Formula	Reduced formula	Compulsory ingredients	Possibilities	Exclude ingredients
africaine	(3) oignons, tomates, poivron, ail, bouquet garni, basilic, paprika, cuire qqes min, vin blanc, réduction fond de veau lié, cuire 15 min, brunoise de zestes de citronfond de veau lié	fond de veau lié	$(S1 + S2 + S3 + S4 + S5 + (E/S)) / E$	$(S + (E / S)) / E$			
aïoli	(1) ail broyé avec huile, pomme de terre, lait, jaunes d'œufs (2) (3) ail, jaune d'œuf, huile d'olive, jus de citron, sel, poivre	Aïoli aïoli	H / E H / E	H / E H / E	Ail, huile, sel, poivre	jaunes d'œuf (1, 3), pomme de terre (1), lait (1), jus de citron (3)	
Etc.							

Why only 23 categories?

- **Possible Categories :**

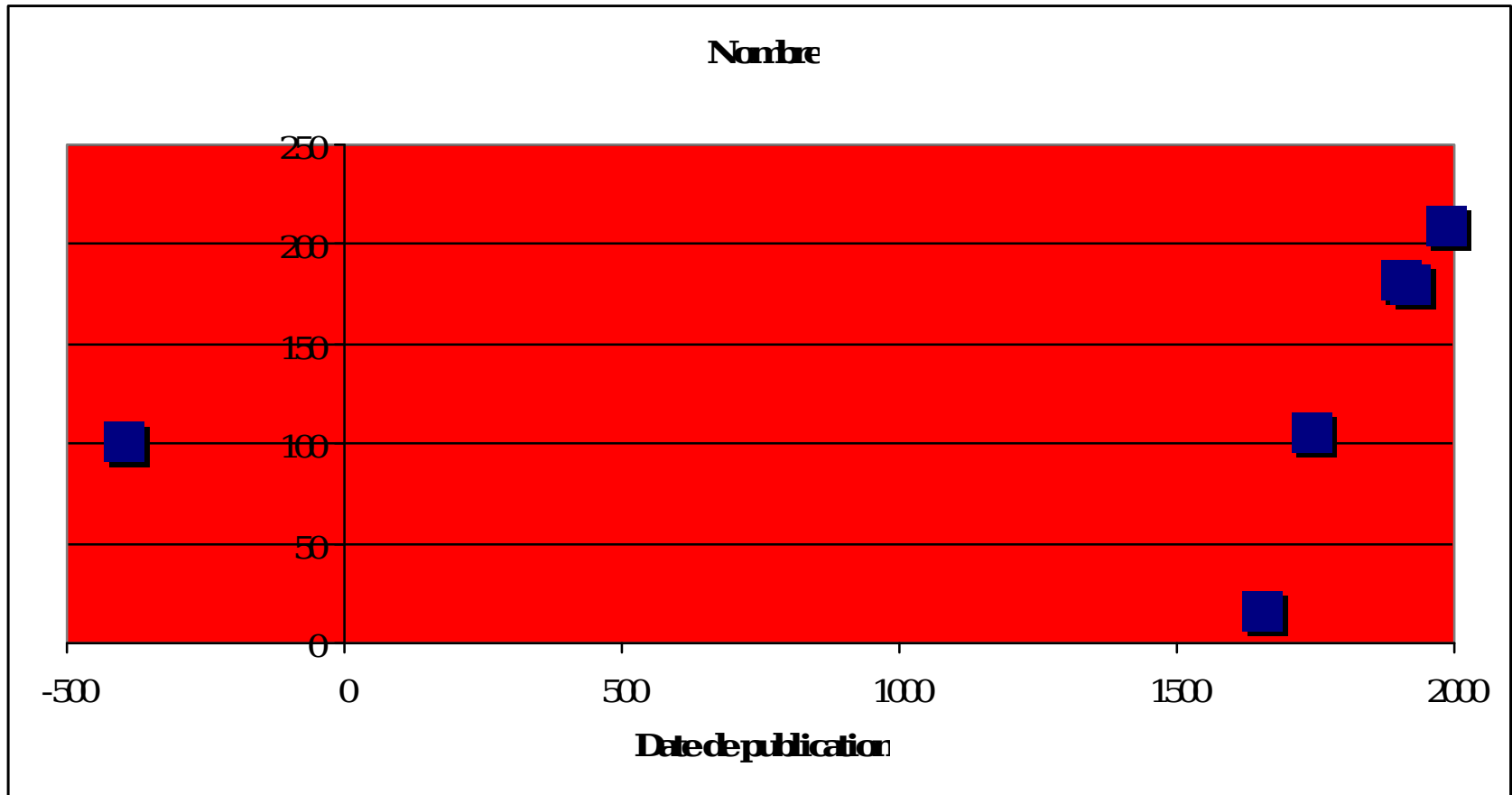
- W
- O
- $W \setminus O$
- $O \setminus W$
- $W \setminus S$
- $W \setminus (S \setminus W)$
- $W \setminus (G + O)$
- $W \setminus (O + S)$
- $W \setminus (O + (S \setminus W))$
- $W \setminus (S + (S \setminus W))$
- $W \setminus (O + (W \setminus (G + O)))$
- $W \setminus (G + O + S)$
- $W \setminus (O + S + (S \setminus W))$
- $W \setminus (O + S + (W \setminus G))$
- $W \setminus (O + S + (W \setminus (G + O)))$
- ...

- **I do not see in the list :**

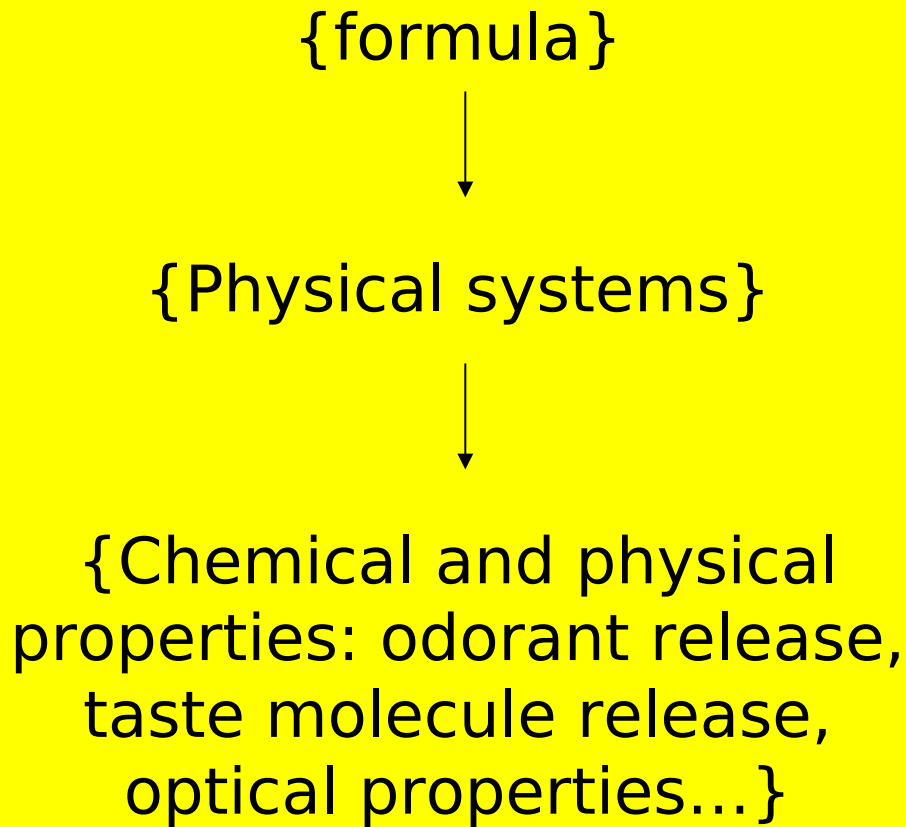
- $W \setminus (G + (S \setminus W))...$

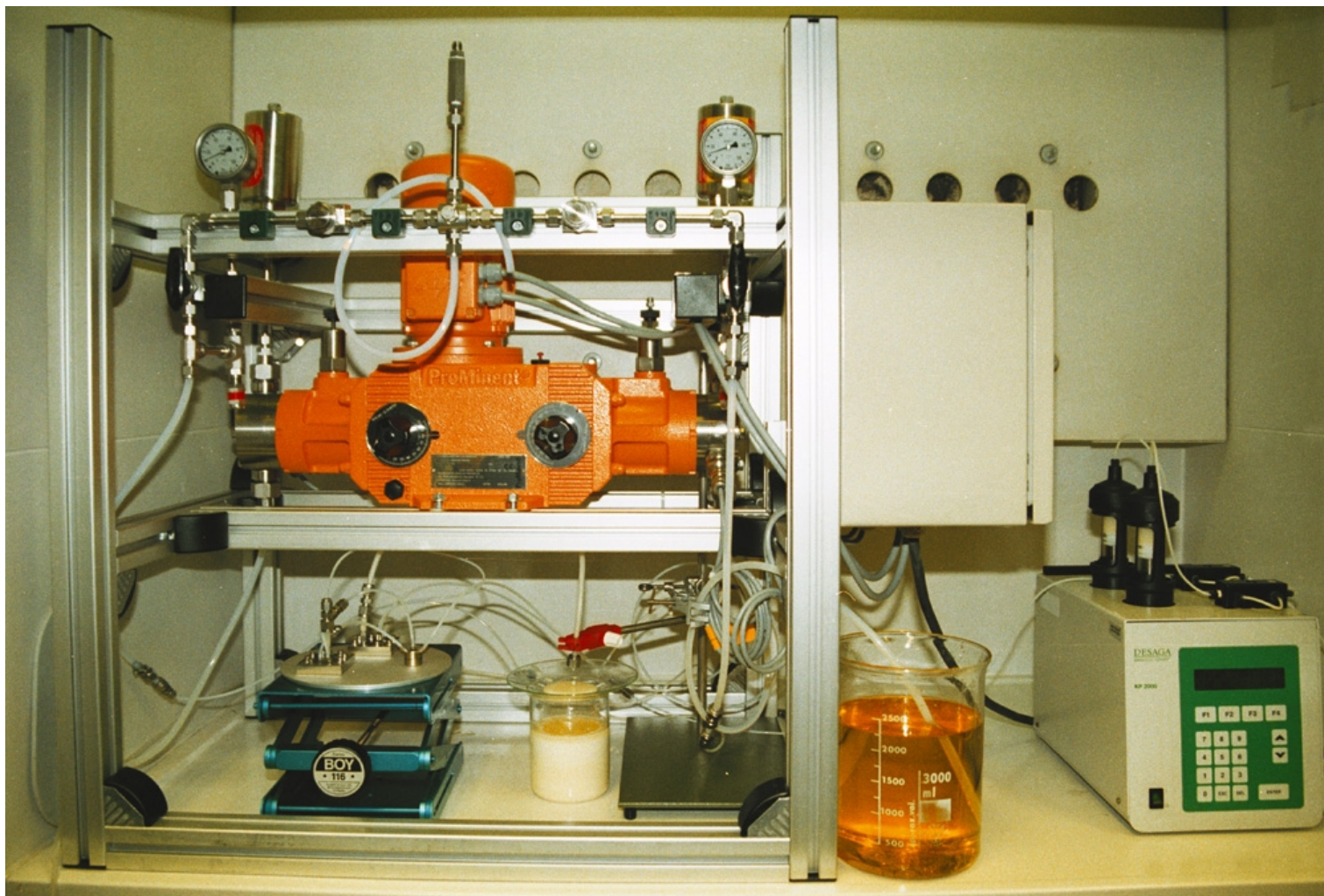
H. This, 14 types de sauces, Pour la Science,
Fev. 2004, 6.

Historical reasons?

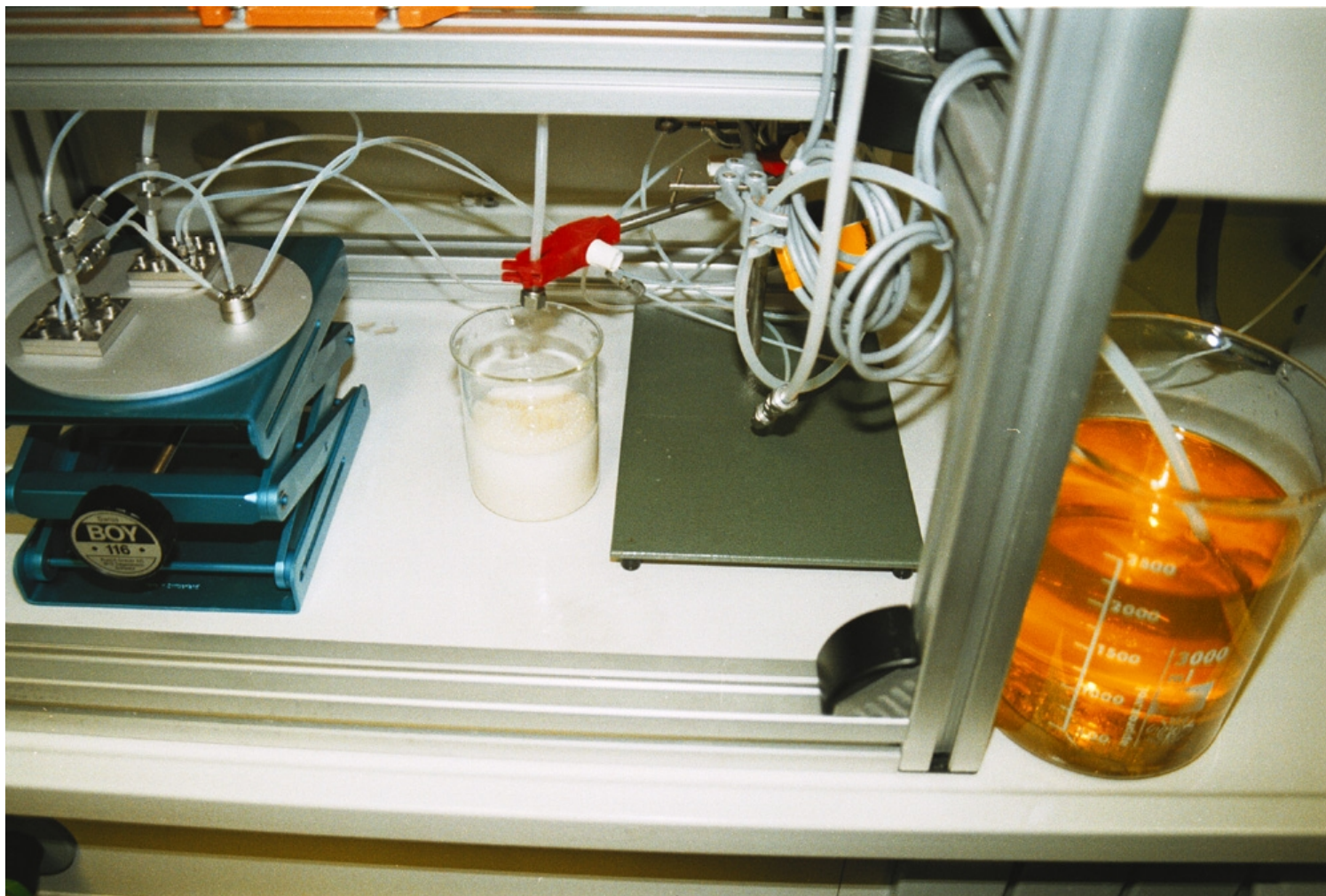


But the main question





W \ (G + O + S)

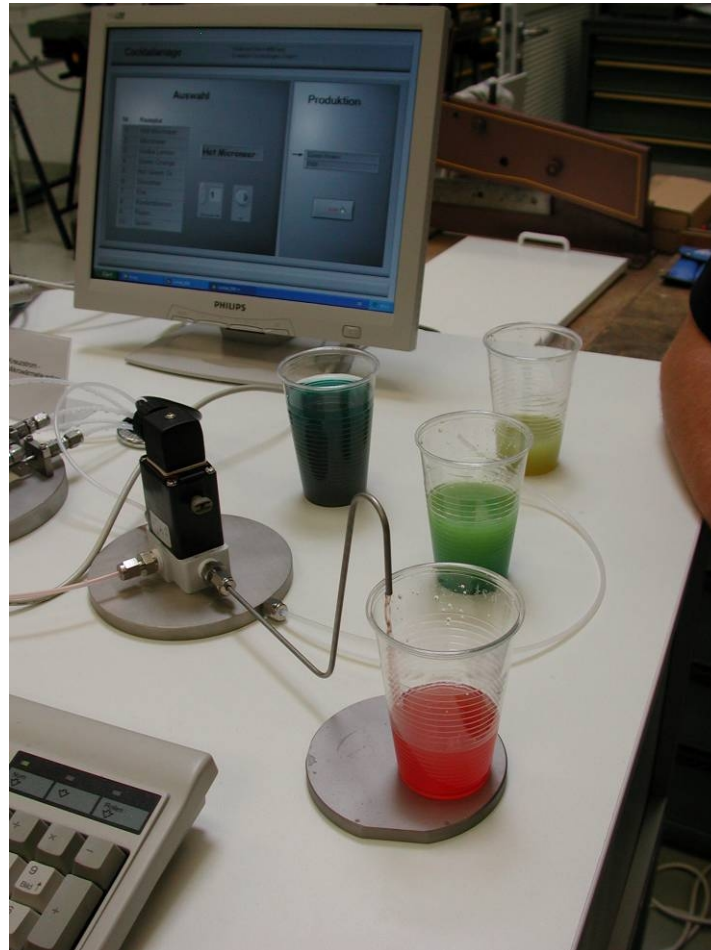




Driven by a computer



Cocktails « sur mesure »



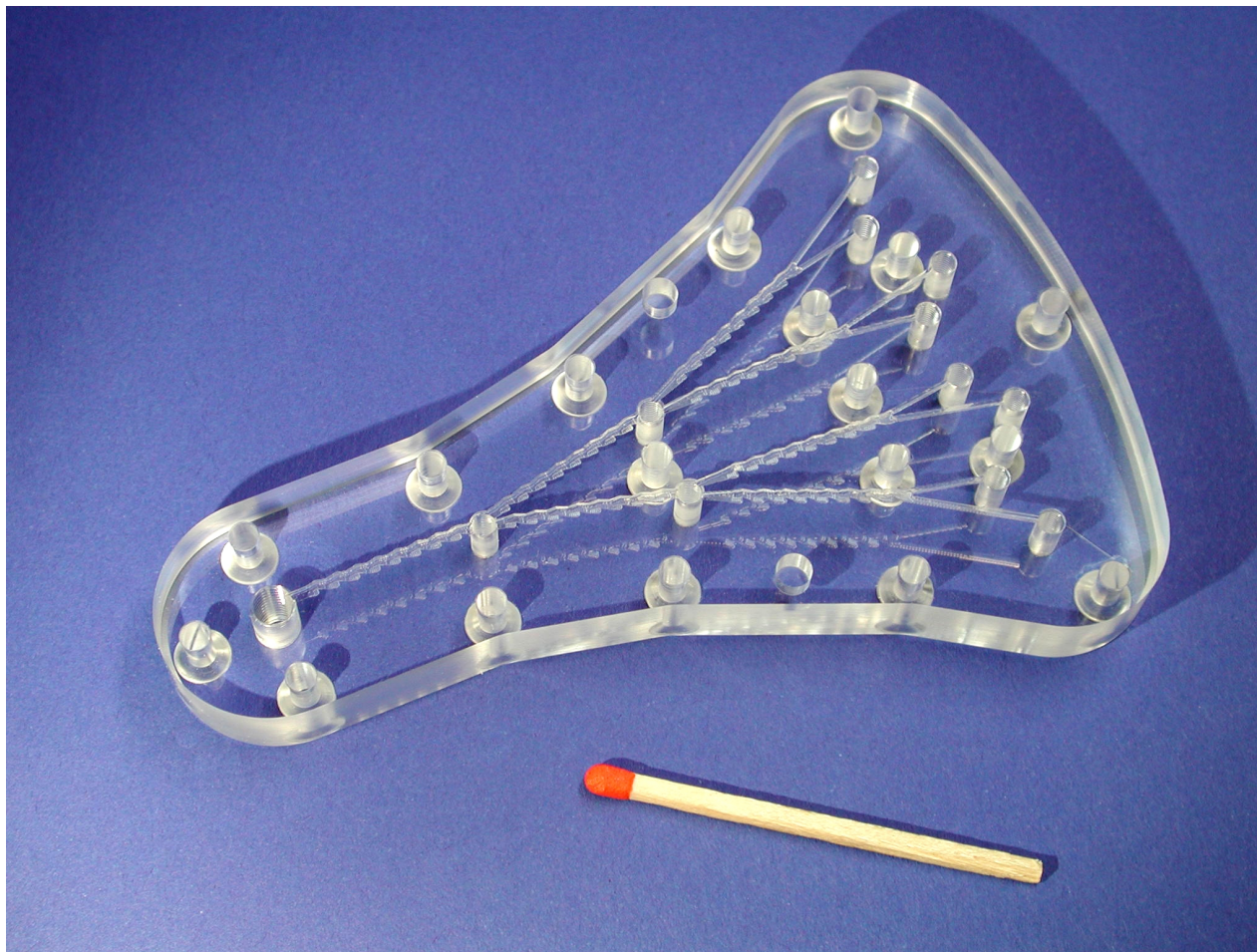


November 2003 : “Pianocktail”





Using this microfluidic system, 500 000 000 000 possibilities



All gels are here!

(Gels of class 2)

- phase := [W, O, S];
- dimension := [D0, D1, D2, D3];
- operateur := ["X", "/", "@", "σ"];
- formule := ""; graine := "";
- for dim1 to 4 do
- for phas1 to 3 do
- for ope to 4 do
- for dim2 to 4 do
- for phas2 to 3 do
- if phas1 <> phas2 then formule := cat(graine, dimension[dim1], "(", phase[phas1], ")", operateur[ope],
- dimension[dim2], "(", phase[phas2], ")")
- end if
- end do
- end do
- end do
- end do
- end do;
-
-

Slightly less than 1500 new systems!

[D0(W)XD0(W)]XD3(S) ::	[D0(W)/D2(W)]XD3(S)	[D0(W)σD0(W)]/D3(S)	[D0(W)+D1(S)]/D3(S)	[D0(O)/D0(O)]XD3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)XD0(W)]/D3(S) :	[D0(W)/D2(W)]/D3(S)	[D0(W)σD0(O)]XD3(S)	[D0(W)+D2(W)]XD3(S)	[D0(O)/D0(O)]/D3(S)	[D0(O)@D2(S)]XD3(S) :
[D0(W)XD0(O)]XD3(S) :	[D0(W)/D2(O)]XD3(S)	[D0(W)σD0(O)]/D3(S)	[D0(W)+D2(W)]/D3(S)	[D0(O)/D0(S)]XD3(S) :	[D0(O)@D2(S)]/D3(S)
[D0(W)XD0(O)]/D3(S) :	[D0(W)/D2(O)]/D3(S)	[D0(W)σD0(S)]XD3(S)	[D0(W)+D2(O)]XD3(S)	[D0(O)/D1(W)]XD3(S)	[D0(O)@D3(W)]XD3(S)
[D0(W)XD0(S)]XD3(S) :	[D0(W)/D2(S)]XD3(S)	[D0(W)σD0(S)]/D3(S)	[D0(W)+D2(O)]/D3(S)	[D0(O)/D1(W)]/D3(S)	[D0(O)@D3(W)]/D3(S) :
[D0(W)XD0(S)]/D3(S) :	[D0(W)/D2(S)]/D3(S)	[D0(W)σD1(W)]XD3(S) :	[D0(W)+D2(S)]XD3(S)	[D0(O)/D1(O)]XD3(S)	[D0(O)@D3(O)]XD3(S) :
[D0(W)XD1(W)]XD3(S) :	[D0(W)/D3(W)]XD3(S)	[D0(W)σD1(W)]/D3(S) :	[D0(W)+D2(S)]/D3(S)	[D0(O)/D1(O)]/D3(S)	[D0(O)@D3(O)]/D3(S)
[D0(W)XD1(W)]/D3(S) :	[D0(W)/D3(W)]/D3(S)	[D0(W)σD1(O)]XD3(S) :	[D0(W)+D3(W)]XD3(S)	[D0(O)/D1(S)]XD3(S)	[D0(O)@D3(S)]XD3(S) :
[D0(W)XD1(O)]XD3(S) :	[D0(W)/D3(O)]XD3(S)	[D0(W)σD1(O)]/D3(S) :	[D0(W)+D3(W)]/D3(S)	[D0(O)/D1(S)]/D3(S)	[D0(O)@D3(S)]/D3(S)
[D0(W)XD1(O)]/D3(S) :	[D0(W)/D3(O)]/D3(S)	[D0(W)σD1(O)]/D3(S) :	[D0(W)+D3(O)]XD3(S)	[D0(O)/D1(S)]/D3(S)	[D0(O)σD0(W)]XD3(S)
[D0(W)XD1(S)]XD3(S) :	[D0(W)/D3(S)]XD3(S)	[D0(W)σD1(S)]XD3(S) :	[D0(W)+D3(O)]/D3(S)	[D0(O)/D2(W)]XD3(S)	[D0(O)σD0(W)]/D3(S) :
[D0(W)XD1(S)]/D3(S) :	[D0(W)/D3(S)]/D3(S)	[D0(W)σD1(S)]/D3(S)	[D0(W)+D3(S)]XD3(S)	[D0(O)/D2(W)]/D3(S)	[D0(O)σD0(O)]XD3(S)
[D0(W)XD2(W)]XD3(S)	[D0(W)XD2(W)]XD3(S)	[D0(W)σD2(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)/D2(O)]XD3(S)	[D0(O)σD0(O)]/D3(S)
[D0(W)XD2(W)]/D3(S)	[D0(W)@D0(W)]/D3(S)	[D0(W)σD2(W)]/D3(S)	[D0(O)XD0(W)]XD3(S)	[D0(O)/D2(O)]/D3(S)	[D0(O)σD0(S)]XD3(S)
[D0(W)XD2(O)]XD3(S)	[D0(W)@D0(O)]XD3(S)	[D0(W)σD2(O)]XD3(S)	[D0(O)XD0(W)]/D3(S)	[D0(O)/D2(S)]XD3(S)	[D0(O)σD0(S)]/D3(S)
[D0(W)XD2(O)]/D3(S)	[D0(W)@D0(O)]/D3(S)	[D0(W)σD2(O)]/D3(S)	[D0(O)XD0(O)]XD3(S)	[D0(O)/D2(S)]/D3(S)	[D0(O)σD0(S)]/D3(S)
[D0(W)XD2(S)]XD3(S)	[D0(W)@D0(S)]XD3(S)	[D0(W)σD2(O)]/D3(S)	[D0(O)XD0(O)]/D3(S)	[D0(O)/D3(W)]XD3(S)	[D0(O)σD1(W)]XD3(S)
[D0(W)XD2(S)]/D3(S)	[D0(W)@D0(S)]/D3(S)	[D0(W)σD2(S)]XD3(S)	[D0(O)XD0(S)]XD3(S)	[D0(O)/D3(W)]/D3(S)	[D0(O)σD1(W)]/D3(S)
[D0(W)XD3(W)]XD3(S)	[D0(W)@D1(W)]XD3(S)	[D0(W)σD2(S)]/D3(S)	[D0(O)XD0(S)]/D3(S)	[D0(O)/D3(O)]XD3(S)	[D0(O)σD1(O)]XD3(S)
[D0(W)XD3(W)]/D3(S) :	[D0(W)@D1(W)]/D3(S)	[D0(W)σD3(W)]XD3(S)	[D0(O)XD1(W)]XD3(S)	[D0(O)/D3(O)]/D3(S)	[D0(O)σD1(O)]/D3(S)
[D0(W)XD3(O)]XD3(S)	[D0(W)@D1(O)]XD3(S)	[D0(W)σD3(W)]/D3(S)	[D0(O)XD1(O)]XD3(S)	[D0(O)/D3(S)]XD3(S)	[D0(O)σD1(S)]XD3(S) :
[D0(W)XD3(O)]/D3(S)	[D0(W)@D1(O)]/D3(S)	[D0(W)σD3(O)]XD3(S)	[D0(O)XD1(W)]/D3(S)	[D0(O)/D3(S)]/D3(S)	[D0(O)σD1(S)]/D3(S)
[D0(W)XD3(S)]XD3(S) :	[D0(W)@D1(S)]XD3(S)	[D0(W)σD3(O)]/D3(S)	[D0(O)XD1(O)]/D3(S)	[D0(O)@D0(W)]XD3(S)	[D0(O)σD2(W)]XD3(S)
[D0(W)XD3(S)]/D3(S)	[D0(W)@D1(S)]/D3(S)	[D0(W)σD3(O)]/D3(S)	[D0(O)XD1(S)]XD3(S)	[D0(O)@D0(W)]/D3(S)	[D0(O)σD2(W)]/D3(S) :
[D0(W)/D0(W)]XD3(S) :	[D0(W)@D2(W)]XD3(S)	[D0(W)σD3(S)]XD3(S)	[D0(O)XD1(S)]/D3(S)	[D0(O)@D0(O)]XD3(S)	[D0(O)σD2(O)]XD3(S)
[D0(W)/D0(W)]/D3(S)	[D0(W)@D2(W)]/D3(S)	[D0(W)σD3(S)]/D3(S)	[D0(O)XD2(W)]XD3(S)	[D0(O)@D0(O)]/D3(S)	[D0(O)σD2(O)]/D3(S)
[D0(W)/D0(O)]XD3(S)	[D0(W)@D2(O)]XD3(S)	[D0(W)+D0(W)]XD3(S)	[D0(O)XD2(W)]/D3(S)	[D0(O)@D0(S)]XD3(S)	[D0(O)σD2(O)]/D3(S)
[D0(W)/D0(O)]/D3(S)	[D0(W)@D2(O)]/D3(S)	[D0(W)+D0(W)]/D3(S)	[D0(O)XD2(O)]XD3(S)	[D0(O)@D0(S)]/D3(S)	[D0(O)σD2(S)]XD3(S)
[D0(W)/D0(S)]XD3(S)	[D0(W)@D2(S)]XD3(S)	[D0(W)+D0(O)]XD3(S)	[D0(O)XD2(O)]/D3(S)	[D0(O)@D0(S)]/D3(S)	[D0(O)σD2(S)]/D3(S)
[D0(W)/D0(S)]/D3(S) :	[D0(W)@D2(S)]/D3(S)	[D0(W)+D0(O)]/D3(S)	[D0(O)XD2(S)]XD3(S)	[D0(O)@D1(W)]XD3(S)	[D0(O)σD2(S)]/D3(S)
[D0(W)/D1(W)]XD3(S) :	[D0(W)@D3(W)]XD3(S)	[D0(W)@D3(W)]XD3(S)	[D0(O)XD2(S)]/D3(S)	[D0(O)@D1(W)]/D3(S)	[D0(O)σD3(W)]XD3(S) :
[D0(W)/D1(W)]/D3(S)	[D0(W)@D3(W)]/D3(S)	[D0(W)+D0(S)]XD3(S)	[D0(O)XD3(W)]XD3(S)	[D0(O)@D1(W)]/D3(S)	[D0(O)σD3(W)]/D3(S) :
[D0(W)/D1(O)]XD3(S)	[D0(W)@D3(O)]XD3(S)	[D0(W)+D1(W)]XD3(S) :	[D0(O)XD3(W)]/D3(S)	[D0(O)@D1(S)]XD3(S)	[D0(O)σD3(O)]XD3(S) :
[D0(W)/D1(O)]/D3(S)	[D0(W)@D3(O)]/D3(S)	[D0(W)+D1(W)]/D3(S) :	[D0(O)XD3(O)]XD3(S)	[D0(O)@D1(S)]/D3(S)	[D0(O)σD3(O)]/D3(S)
[D0(W)/D1(S)]XD3(S)	[D0(W)@D3(S)]XD3(S)	[D0(W)+D1(O)]XD3(S)	[D0(O)XD3(O)]/D3(S)	[D0(O)@D2(W)]XD3(S)	[D0(O)σD3(S)]XD3(S) :
[D0(W)/D1(S)]/D3(S) :	[D0(W)@D3(S)]/D3(S)	[D0(W)+D1(O)]/D3(S)	[D0(O)XD3(S)]XD3(S)	[D0(O)@D2(W)]/D3(S)	[D0(O)σD3(S)]/D3(S)
	[D0(W)σD0(W)]XD3(S)	[D0(W)+D1(S)]XD3(S)	[D0(O)XD3(S)]/D3(S)	[D0(O)@D2(O)]XD3(S)	[D0(O)σD3(S)]/D3(S) :

And here...

[D0(W)XD0(W)]XD3(S) ::	[D0(W)/D2(W)]XD3(S)	[D0(W)σD0(W)]/D3(S)	[D0(W)+D1(S)]/D3(S)	[D0(O)/D0(O)]XD3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)XD0(W)]/D3(S) :	[D0(W)/D2(W)]/D3(S)	[D0(W)σD0(O)]XD3(S)	[D0(W)+D2(W)]XD3(S)	[D0(O)/D0(O)]/D3(S)	[D0(O)@D2(S)]XD3(S) :
[D0(W)XD0(O)]XD3(S) :	[D0(W)/D2(O)]XD3(S)	[D0(W)σD0(O)]/D3(S)	[D0(W)+D2(W)]/D3(S)	[D0(O)/D0(S)]XD3(S) :	[D0(O)@D2(S)]/D3(S)
[D0(W)XD0(O)]/D3(S) :	[D0(W)/D2(O)]/D3(S)	[D0(W)σD0(S)]XD3(S)	[D0(W)+D2(O)]XD3(S)	[D0(O)/D1(W)]XD3(S)	[D0(O)@D3(W)]XD3(S)
[D0(W)XD0(S)]XD3(S) :	[D0(W)/D2(S)]XD3(S)	[D0(W)σD0(S)]/D3(S) :	[D0(W)+D2(O)]/D3(S)	[D0(O)/D1(W)]/D3(S) :	[D0(O)@D3(W)]/D3(S) :
[D0(W)XD0(S)]/D3(S) :	[D0(W)/D2(S)]/D3(S)	[D0(W)σD1(W)]XD3(S) :	[D0(W)+D2(S)]XD3(S)	[D0(O)/D1(O)]XD3(S)	[D0(O)@D3(O)]XD3(S) :
[D0(W)XD1(W)]XD3(S) :	[D0(W)/D3(W)]XD3(S)	[D0(W)σD1(W)]/D3(S) :	[D0(W)+D2(S)]/D3(S)	[D0(O)/D1(O)]/D3(S) :	[D0(O)@D3(O)]/D3(S) :
[D0(W)XD1(W)]/D3(S) :	[D0(W)/D3(W)]/D3(S)	[D0(W)σD1(O)]XD3(S) :	[D0(W)+D3(W)]XD3(S)	[D0(O)/D1(S)]XD3(S)	[D0(O)@D3(S)]XD3(S) :
[D0(W)XD1(O)]XD3(S) :	[D0(W)/D3(O)]XD3(S)	[D0(W)σD1(O)]/D3(S) :	[D0(W)+D3(W)]/D3(S)	[D0(O)/D1(S)]/D3(S) :	[D0(O)@D3(S)]/D3(S)
[D0(W)XD1(O)]/D3(S) :	[D0(W)/D3(O)]/D3(S)	[D0(W)σD1(S)]XD3(S) :	[D0(W)+D3(O)]XD3(S)	[D0(O)/D2(W)]XD3(S)	[D0(O)σD0(W)]XD3(S)
[D0(W)XD1(S)]XD3(S) :	[D0(W)/D3(S)]XD3(S)	[D0(W)σD1(S)]/D3(S)	[D0(W)+D3(O)]/D3(S)	[D0(O)/D2(W)]/D3(S) :	[D0(O)σD0(W)]/D3(S) :
[D0(W)XD1(S)]/D3(S)	[D0(W)/D3(S)]/D3(S)	[D0(W)σD1(S)]/D3(S)	[D0(W)+D3(S)]XD3(S)	[D0(O)/D2(O)]XD3(S)	[D0(O)σD0(O)]XD3(S)
[D0(W)XD2(W)]XD3(S)	[D0(W)@D0(W)]XD3(S)	[D0(W)σD2(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)/D2(O)]/D3(S)	[D0(O)σD0(O)]/D3(S)
[D0(W)XD2(W)]/D3(S)	[D0(W)@D0(W)]/D3(S)	[D0(W)σD2(W)]/D3(S)	[D0(O)XD0(W)]XD3(S)	[D0(O)/D2(O)]/D3(S)	[D0(O)σD0(S)]XD3(S)
[D0(W)XD2(O)]XD3(S)	[D0(W)@D0(O)]XD3(S)	[D0(W)σD2(O)]XD3(S)	[D0(O)XD0(W)]/D3(S)	[D0(O)/D2(S)]XD3(S)	[D0(O)σD0(S)]/D3(S)
[D0(W)XD2(O)]/D3(S)	[D0(W)@D0(O)]/D3(S)	[D0(W)σD2(O)]/D3(S)	[D0(O)XD0(O)]XD3(S)	[D0(O)/D2(S)]/D3(S)	[D0(O)σD0(S)]/D3(S)
[D0(W)XD2(S)]XD3(S)	[D0(W)@D0(S)]XD3(S)	[D0(W)σD2(O)]/D3(S)	[D0(O)XD0(O)]/D3(S)	[D0(O)/D3(W)]XD3(S)	[D0(O)σD1(W)]XD3(S)
[D0(W)XD2(S)]/D3(S)	[D0(W)@D0(S)]/D3(S)	[D0(W)σD2(S)]XD3(S)	[D0(O)XD0(O)]/D3(S)	[D0(O)/D3(W)]/D3(S)	[D0(O)σD1(W)]/D3(S)
[D0(W)XD3(W)]XD3(S)	[D0(W)@D1(W)]XD3(S)	[D0(W)σD2(S)]/D3(S)	[D0(O)XD1(W)]XD3(S)	[D0(O)/D3(O)]XD3(S)	[D0(O)σD1(O)]XD3(S)
[D0(W)XD3(W)]/D3(S) :	[D0(W)@D1(W)]/D3(S)	[D0(W)σD3(W)]XD3(S)	[D0(O)XD1(W)]/D3(S)	[D0(O)/D3(O)]/D3(S)	[D0(O)σD1(O)]/D3(S)
[D0(W)XD3(O)]XD3(S)	[D0(W)@D1(O)]XD3(S)	[D0(W)σD3(W)]/D3(S)	[D0(O)XD1(O)]XD3(S)	[D0(O)/D3(S)]XD3(S)	[D0(O)σD1(S)]XD3(S) :
[D0(W)XD3(O)]/D3(S)	[D0(W)@D1(O)]/D3(S)	[D0(W)σD3(O)]XD3(S)	[D0(O)XD1(O)]/D3(S)	[D0(O)/D3(S)]/D3(S)	[D0(O)σD1(S)]/D3(S)
[D0(W)XD3(S)]XD3(S) :	[D0(W)@D1(S)]XD3(S)	[D0(W)σD3(O)]/D3(S)	[D0(O)XD1(S)]XD3(S)	[D0(O)@D0(W)]XD3(S)	[D0(O)σD2(W)]XD3(S)
[D0(W)XD3(S)]/D3(S)	[D0(W)@D1(S)]/D3(S)	[D0(W)σD3(S)]XD3(S)	[D0(O)XD1(S)]/D3(S)	[D0(O)@D0(O)]XD3(S)	[D0(O)σD2(W)]/D3(S) :
[D0(W)/D0(W)]XD3(S) :	[D0(W)@D2(W)]XD3(S)	[D0(W)σD3(S)]/D3(S)	[D0(O)XD2(W)]XD3(S)	[D0(O)@D0(O)]/D3(S)	[D0(O)σD2(O)]XD3(S)
[D0(W)/D0(W)]/D3(S)	[D0(W)@D2(W)]/D3(S)	[D0(W)σD3(S)]/D3(S)	[D0(O)XD2(W)]/D3(S)	[D0(O)@D0(S)]XD3(S)	[D0(O)σD2(O)]/D3(S)
[D0(W)/D0(O)]XD3(S)	[D0(W)@D2(O)]XD3(S)	[D0(W)+D0(W)]/D3(S)	[D0(O)XD2(O)]XD3(S)	[D0(O)@D0(S)]/D3(S)	[D0(O)σD2(S)]XD3(S)
[D0(W)/D0(O)]/D3(S)	[D0(W)@D2(O)]/D3(S)	[D0(W)+D0(O)]XD3(S)	[D0(O)XD2(O)]/D3(S)	[D0(O)@D1(W)]XD3(S)	[D0(O)σD2(S)]/D3(S)
[D0(W)/D0(S)]XD3(S)	[D0(W)@D2(S)]XD3(S)	[D0(W)+D0(O)]/D3(S)	[D0(O)XD2(S)]XD3(S)	[D0(O)@D1(W)]/D3(S)	[D0(O)σD2(S)]/D3(S)
[D0(W)/D0(S)]/D3(S)	[D0(W)@D2(S)]/D3(S)	[D0(W)@D3(W)]XD3(S)	[D0(O)XD2(S)]/D3(S)	[D0(O)@D1(O)]XD3(S)	[D0(O)σD3(W)]XD3(S) :
[D0(W)/D1(W)]XD3(S)	[D0(W)@D3(W)]XD3(S)	[D0(W)+D0(S)]XD3(S)	[D0(O)XD3(W)]XD3(S)	[D0(O)@D1(O)]/D3(S)	[D0(O)σD3(W)]/D3(S) :
[D0(W)/D1(W)]/D3(S)	[D0(W)@D3(W)]/D3(S)	[D0(W)+D1(W)]XD3(S) :	[D0(O)XD3(W)]/D3(S)	[D0(O)@D1(S)]XD3(S)	[D0(O)σD3(O)]XD3(S) :
[D0(W)/D1(O)]XD3(S)	[D0(W)@D3(O)]XD3(S)	[D0(W)+D1(W)]/D3(S) :	[D0(O)XD3(O)]XD3(S)	[D0(O)@D1(S)]/D3(S)	[D0(O)σD3(O)]/D3(S) :
[D0(W)/D1(O)]/D3(S)	[D0(W)@D3(O)]/D3(S)	[D0(W)+D1(O)]XD3(S)	[D0(O)XD3(O)]/D3(S)	[D0(O)@D2(W)]XD3(S)	[D0(O)σD3(S)]XD3(S) :
[D0(W)/D1(S)]XD3(S)	[D0(W)@D3(S)]XD3(S)	[D0(W)+D1(O)]/D3(S)	[D0(O)XD3(S)]XD3(S)	[D0(O)@D2(W)]/D3(S)	[D0(O)σD3(S)]/D3(S) :
[D0(W)/D1(S)]/D3(S) :	[D0(W)σD0(W)]XD3(S)	[D0(W)+D1(S)]XD3(S)	[D0(O)XD3(S)]/D3(S)	[D0(O)@D2(O)]XD3(S)	[D0(O)σD3(S)]/D3(S) :

And again here...

[D0(W)XD0(W)]XD3(S) ::	[D0(W)/D2(W)]XD3(S)	[D0(W)σD0(W)]/D3(S)	[D0(W)+D1(S)]/D3(S)	[D0(O)/D0(O)]XD3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)XD0(W)]/D3(S) :	[D0(W)/D2(W)]/D3(S)	[D0(W)σD0(O)]XD3(S)	[D0(W)+D2(W)]XD3(S)	[D0(O)/D0(O)]/D3(S)	[D0(O)@D2(S)]XD3(S) :
[D0(W)XD0(O)]XD3(S) :	[D0(W)/D2(O)]XD3(S)	[D0(W)σD0(O)]/D3(S)	[D0(W)+D2(W)]/D3(S)	[D0(O)/D0(S)]XD3(S) :	[D0(O)@D2(S)]/D3(S)
[D0(W)XD0(O)]/D3(S) :	[D0(W)/D2(O)]/D3(S)	[D0(W)σD0(S)]XD3(S)	[D0(W)+D2(O)]XD3(S)	[D0(O)/D1(W)]XD3(S)	[D0(O)@D3(W)]XD3(S)
[D0(W)XD0(S)]XD3(S) :	[D0(W)/D2(S)]XD3(S)	[D0(W)σD0(S)]/D3(S) :	[D0(W)+D2(O)]/D3(S)	[D0(O)/D1(W)]/D3(S) :	[D0(O)@D3(W)]/D3(S) :
[D0(W)XD0(S)]/D3(S) :	[D0(W)/D2(S)]/D3(S)	[D0(W)σD1(W)]XD3(S) :	[D0(W)+D2(S)]XD3(S)	[D0(O)/D1(O)]XD3(S)	[D0(O)@D3(O)]XD3(S) :
[D0(W)XD1(W)]XD3(S) :	[D0(W)/D3(W)]XD3(S)	[D0(W)σD1(W)]/D3(S) :	[D0(W)+D2(S)]/D3(S)	[D0(O)/D1(O)]/D3(S) :	[D0(O)@D3(O)]/D3(S) :
[D0(W)XD1(W)]/D3(S) :	[D0(W)/D3(W)]/D3(S)	[D0(W)σD1(O)]XD3(S) :	[D0(W)+D3(W)]XD3(S)	[D0(O)/D1(S)]XD3(S)	[D0(O)@D3(S)]XD3(S) :
[D0(W)XD1(O)]XD3(S) :	[D0(W)/D3(O)]XD3(S)	[D0(W)σD1(O)]/D3(S) :	[D0(W)+D3(W)]/D3(S)	[D0(O)/D1(S)]/D3(S) :	[D0(O)@D3(S)]/D3(S)
[D0(W)XD1(O)]/D3(S) :	[D0(W)/D3(O)]/D3(S)	[D0(W)σD1(S)]XD3(S) :	[D0(W)+D3(O)]XD3(S)	[D0(O)/D2(W)]XD3(S)	[D0(O)σD0(W)]XD3(S)
[D0(W)XD1(S)]XD3(S) :	[D0(W)/D3(S)]XD3(S)	[D0(W)σD1(S)]/D3(S)	[D0(W)+D3(O)]/D3(S)	[D0(O)/D2(W)]/D3(S) :	[D0(O)σD0(W)]/D3(S) :
[D0(W)XD1(S)]/D3(S)	[D0(W)/D3(S)]/D3(S)	[D0(W)σD1(S)]/D3(S)	[D0(W)+D3(S)]XD3(S)	[D0(O)/D2(O)]XD3(S)	[D0(O)σD0(O)]XD3(S)
[D0(W)XD2(W)]XD3(S)	[D0(W)@D0(W)]XD3(S)	[D0(W)σD2(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)/D2(O)]/D3(S)	[D0(O)σD0(O)]/D3(S)
[D0(W)XD2(W)]/D3(S)	[D0(W)@D0(W)]/D3(S)	[D0(W)σD2(W)]/D3(S)	[D0(O)XD0(W)]XD3(S)	[D0(O)/D2(O)]/D3(S)	[D0(O)σD0(S)]XD3(S)
[D0(W)XD2(O)]XD3(S)	[D0(W)@D0(O)]XD3(S)	[D0(W)σD2(O)]XD3(S)	[D0(O)XD0(W)]/D3(S)	[D0(O)/D2(S)]XD3(S)	[D0(O)σD0(S)]/D3(S)
[D0(W)XD2(O)]/D3(S)	[D0(W)@D0(O)]/D3(S)	[D0(W)σD2(O)]/D3(S)	[D0(O)XD0(O)]XD3(S)	[D0(O)/D2(S)]/D3(S)	[D0(O)σD0(S)]/D3(S)
[D0(W)XD2(S)]XD3(S)	[D0(W)@D0(S)]XD3(S)	[D0(W)σD2(S)]XD3(S)	[D0(O)XD0(O)]/D3(S)	[D0(O)/D3(W)]XD3(S)	[D0(O)σD1(W)]XD3(S)
[D0(W)XD2(S)]/D3(S)	[D0(W)@D0(S)]/D3(S)	[D0(W)σD2(S)]/D3(S)	[D0(O)XD0(O)]/D3(S)	[D0(O)/D3(W)]/D3(S)	[D0(O)σD1(W)]/D3(S)
[D0(W)XD3(W)]XD3(S)	[D0(W)@D1(W)]XD3(S)	[D0(W)σD2(S)]/D3(S)	[D0(O)XD0(S)]/D3(S)	[D0(O)/D3(O)]XD3(S)	[D0(O)σD1(O)]XD3(S)
[D0(W)XD3(W)]/D3(S) :	[D0(W)@D1(W)]/D3(S)	[D0(W)σD3(W)]XD3(S)	[D0(O)XD1(W)]XD3(S)	[D0(O)/D3(O)]/D3(S)	[D0(O)σD1(O)]/D3(S)
[D0(W)XD3(O)]XD3(S)	[D0(W)@D1(O)]XD3(S)	[D0(W)σD3(W)]/D3(S)	[D0(O)XD1(W)]/D3(S)	[D0(O)/D3(S)]XD3(S)	[D0(O)σD1(S)]XD3(S) :
[D0(W)XD3(O)]/D3(S)	[D0(W)@D1(O)]/D3(S)	[D0(W)σD3(O)]XD3(S)	[D0(O)XD1(O)]/D3(S)	[D0(O)/D3(S)]/D3(S)	[D0(O)σD1(S)]/D3(S)
[D0(W)XD3(S)]XD3(S) :	[D0(W)@D1(S)]XD3(S)	[D0(W)σD3(O)]/D3(S)	[D0(O)XD1(S)]XD3(S)	[D0(O)@D0(W)]XD3(S)	[D0(O)σD2(W)]XD3(S)
[D0(W)XD3(S)]/D3(S)	[D0(W)@D1(S)]/D3(S)	[D0(W)σD3(S)]XD3(S)	[D0(O)XD1(S)]/D3(S)	[D0(O)@D0(W)]/D3(S)	[D0(O)σD2(W)]/D3(S) :
[D0(W)/D0(W)]XD3(S) :	[D0(W)@D2(W)]XD3(S)	[D0(W)σD3(S)]/D3(S)	[D0(O)XD2(W)]XD3(S)	[D0(O)@D0(O)]XD3(S)	[D0(O)σD2(O)]XD3(S)
[D0(W)/D0(W)]/D3(S)	[D0(W)@D2(W)]/D3(S)	[D0(W)σD3(S)]/D3(S)	[D0(O)XD2(W)]/D3(S)	[D0(O)@D0(O)]/D3(S)	[D0(O)σD2(O)]/D3(S)
[D0(W)/D0(O)]XD3(S)	[D0(W)@D2(O)]XD3(S)	[D0(W)+D0(W)]XD3(S)	[D0(O)XD2(O)]XD3(S)	[D0(O)@D0(S)]XD3(S)	[D0(O)σD2(O)]/D3(S)
[D0(W)/D0(O)]/D3(S)	[D0(W)@D2(O)]/D3(S)	[D0(W)+D0(W)]/D3(S)	[D0(O)XD2(O)]/D3(S)	[D0(O)@D0(S)]/D3(S)	[D0(O)σD2(S)]XD3(S)
[D0(W)/D0(S)]XD3(S)	[D0(W)@D2(S)]XD3(S)	[D0(W)+D0(O)]XD3(S)	[D0(O)XD2(O)]/D3(S)	[D0(O)@D1(W)]XD3(S)	[D0(O)σD2(S)]/D3(S)
[D0(W)/D0(S)]/D3(S)	[D0(W)@D2(S)]/D3(S)	[D0(W)+D0(O)]/D3(S)	[D0(O)XD2(S)]XD3(S)	[D0(O)@D1(W)]/D3(S)	[D0(O)σD2(S)]/D3(S)
[D0(W)/D1(W)]XD3(S) :	[D0(W)@D3(W)]XD3(S)	[D0(W)@D3(W)]XD3(S)	[D0(O)XD2(S)]/D3(S)	[D0(O)@D1(O)]XD3(S)	[D0(O)σD3(W)]XD3(S) :
[D0(W)/D1(W)]/D3(S)	[D0(W)@D3(W)]/D3(S)	[D0(W)+D0(S)]/D3(S) :	[D0(O)XD3(W)]XD3(S)	[D0(O)@D1(O)]/D3(S)	[D0(O)σD3(W)]/D3(S) :
[D0(W)/D1(O)]XD3(S)	[D0(W)@D3(O)]XD3(S)	[D0(W)+D1(W)]XD3(S) :	[D0(O)XD3(W)]/D3(S)	[D0(O)@D1(S)]XD3(S)	[D0(O)σD3(O)]XD3(S) :
[D0(W)/D1(O)]/D3(S)	[D0(W)@D3(O)]/D3(S)	[D0(W)+D1(W)]/D3(S) :	[D0(O)XD3(O)]XD3(S)	[D0(O)@D1(S)]/D3(S)	[D0(O)σD3(O)]/D3(S) :
[D0(W)/D1(S)]XD3(S)	[D0(W)@D3(S)]XD3(S)	[D0(W)+D1(O)]XD3(S)	[D0(O)XD3(O)]/D3(S)	[D0(O)@D2(W)]XD3(S)	[D0(O)σD3(S)]XD3(S) :
[D0(W)/D1(S)]/D3(S) :	[D0(W)@D3(S)]/D3(S)	[D0(W)+D1(O)]/D3(S)	[D0(O)XD3(S)]XD3(S)	[D0(O)@D2(W)]/D3(S)	[D0(O)σD3(S)]XD3(S) :
	[D0(W)σD0(W)]XD3(S)	[D0(W)+D1(S)]XD3(S)	[D0(O)XD3(S)]/D3(S)	[D0(O)@D2(O)]XD3(S)	[D0(O)σD3(S)]/D3(S) :

And finally here

[D0(W)XD0(W)]XD3(S) ::	[D0(W)/D2(W)]XD3(S)	[D0(W)σD0(W)]/D3(S)	[D0(W)+D1(S)]/D3(S)	[D0(O)/D0(O)]XD3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)XD0(W)]/D3(S) ::	[D0(W)/D2(W)]/D3(S)	[D0(W)σD0(O)]XD3(S)	[D0(W)+D2(W)]XD3(S)	[D0(O)/D0(O)]/D3(S)	[D0(O)@D2(S)]XD3(S) ::
[D0(W)XD0(O)]XD3(S) ::	[D0(W)/D2(O)]XD3(S)	[D0(W)σD0(O)]/D3(S)	[D0(W)+D2(W)]/D3(S)	[D0(O)/D0(S)]XD3(S)	[D0(O)@D2(S)]/D3(S)
[D0(W)XD0(O)]/D3(S) ::	[D0(W)/D2(O)]/D3(S)	[D0(W)σD0(S)]XD3(S)	[D0(W)+D2(O)]XD3(S)	[D0(O)/D1(W)]XD3(S)	[D0(O)@D3(W)]XD3(S)
[D0(W)XD0(S)]XD3(S) ::	[D0(W)/D2(S)]XD3(S)	[D0(W)σD0(S)]/D3(S) ::	[D0(W)+D2(O)]/D3(S)	[D0(O)/D1(W)]/D3(S)	[D0(O)@D3(W)]/D3(S) ::
[D0(W)XD0(S)]/D3(S) ::	[D0(W)/D2(S)]/D3(S)	[D0(W)σD1(W)]XD3(S) ::	[D0(W)+D2(S)]XD3(S)	[D0(O)/D1(O)]XD3(S)	[D0(O)@D3(O)]XD3(S) ::
[D0(W)XD1(W)]XD3(S) ::	[D0(W)/D3(W)]XD3(S)	[D0(W)σD1(W)]/D3(S) ::	[D0(W)+D2(S)]/D3(S)	[D0(O)/D1(O)]/D3(S)	[D0(O)@D3(O)]/D3(S)
[D0(W)XD1(W)]/D3(S) ::	[D0(W)/D3(W)]/D3(S)	[D0(W)σD1(O)]XD3(S) ::	[D0(W)+D3(W)]XD3(S)	[D0(O)/D1(S)]XD3(S)	[D0(O)@D3(S)]XD3(S) ::
[D0(W)XD1(O)]XD3(S) ::	[D0(W)/D3(O)]XD3(S)	[D0(W)σD1(O)]/D3(S) ::	[D0(W)+D3(W)]/D3(S)	[D0(O)/D1(S)]/D3(S)	[D0(O)@D3(S)]/D3(S)
[D0(W)XD1(O)]/D3(S) ::	[D0(W)/D3(O)]/D3(S)	[D0(W)σD1(S)]XD3(S) ::	[D0(W)+D3(O)]XD3(S)	[D0(O)/D1(S)]XD3(S)	[D0(O)σD0(W)]XD3(S)
[D0(W)XD1(S)]XD3(S) ::	[D0(W)/D3(S)]XD3(S)	[D0(W)σD1(S)]/D3(S)	[D0(W)+D3(O)]/D3(S)	[D0(O)/D2(W)]XD3(S)	[D0(O)σD0(W)]/D3(S) ::
[D0(W)XD1(S)]/D3(S) ::	[D0(W)/D3(S)]/D3(S)	[D0(W)σD1(S)]/D3(S)	[D0(W)+D3(S)]XD3(S)	[D0(O)/D2(W)]/D3(S)	[D0(O)σD0(O)]XD3(S)
[D0(W)XD2(W)]XD3(S)	[D0(W)XD2(W)]XD3(S)	[D0(W)σD2(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)/D2(O)]XD3(S)	[D0(O)σD0(O)]/D3(S)
[D0(W)XD2(W)]/D3(S)	[D0(W)@D0(W)]/D3(S)	[D0(W)σD2(W)]/D3(S)	[D0(O)XD0(W)]XD3(S)	[D0(O)/D2(O)]/D3(S)	[D0(O)σD0(S)]XD3(S)
[D0(W)XD2(O)]XD3(S)	[D0(W)@D0(O)]XD3(S)	[D0(W)σD2(O)]XD3(S)	[D0(O)XD0(W)]/D3(S)	[D0(O)/D2(S)]XD3(S)	[D0(O)σD0(S)]/D3(S)
[D0(W)XD2(O)]/D3(S)	[D0(W)@D0(O)]/D3(S)	[D0(W)σD2(O)]/D3(S)	[D0(O)XD0(O)]XD3(S)	[D0(O)/D2(S)]/D3(S)	[D0(O)σD0(S)]/D3(S)
[D0(W)XD2(S)]XD3(S)	[D0(W)@D0(S)]XD3(S)	[D0(W)σD2(S)]XD3(S)	[D0(O)XD0(O)]/D3(S)	[D0(O)/D3(W)]XD3(S)	[D0(O)σD1(W)]XD3(S)
[D0(W)XD2(S)]/D3(S)	[D0(W)@D0(S)]/D3(S)	[D0(W)σD2(S)]/D3(S)	[D0(O)XD0(S)]XD3(S)	[D0(O)/D3(W)]/D3(S)	[D0(O)σD1(W)]/D3(S)
[D0(W)XD3(W)]XD3(S)	[D0(W)@D1(W)]XD3(S)	[D0(W)σD2(S)]/D3(S)	[D0(O)XD0(S)]/D3(S)	[D0(O)/D3(O)]XD3(S)	[D0(O)σD1(O)]XD3(S)
[D0(W)XD3(W)]/D3(S) ::	[D0(W)@D1(W)]/D3(S)	[D0(W)σD3(W)]XD3(S)	[D0(O)XD1(W)]XD3(S)	[D0(O)/D3(O)]/D3(S)	[D0(O)σD1(O)]/D3(S)
[D0(W)XD3(O)]XD3(S)	[D0(W)@D1(O)]XD3(S)	[D0(W)σD3(W)]/D3(S)	[D0(O)XD1(O)]XD3(S)	[D0(O)/D3(S)]XD3(S)	[D0(O)σD1(S)]XD3(S) ::
[D0(W)XD3(O)]/D3(S)	[D0(W)@D1(O)]/D3(S)	[D0(W)σD3(O)]XD3(S)	[D0(O)XD1(W)]/D3(S)	[D0(O)/D3(S)]/D3(S)	[D0(O)σD1(S)]/D3(S)
[D0(W)XD3(S)]XD3(S) ::	[D0(W)@D1(S)]XD3(S)	[D0(W)σD3(O)]/D3(S)	[D0(O)XD1(O)]/D3(S)	[D0(O)@D0(W)]XD3(S)	[D0(O)σD2(W)]XD3(S)
[D0(W)XD3(S)]/D3(S)	[D0(W)@D1(S)]/D3(S)	[D0(W)σD3(S)]XD3(S)	[D0(O)XD1(S)]XD3(S)	[D0(O)@D0(W)]/D3(S)	[D0(O)σD2(W)]/D3(S)
[D0(W)/D0(W)]XD3(S) ::	[D0(W)@D2(W)]XD3(S)	[D0(W)σD3(S)]/D3(S)	[D0(O)XD1(S)]/D3(S)	[D0(O)@D0(O)]XD3(S)	[D0(O)σD2(O)]XD3(S)
[D0(W)/D0(W)]/D3(S)	[D0(W)@D2(W)]/D3(S)	[D0(W)σD3(S)]/D3(S)	[D0(O)XD2(W)]XD3(S)	[D0(O)@D0(O)]/D3(S)	[D0(O)σD2(O)]/D3(S)
[D0(W)/D0(O)]XD3(S)	[D0(W)@D2(O)]XD3(S)	[D0(W)+D0(W)]XD3(S) ::	[D0(O)XD2(W)]/D3(S)	[D0(O)@D0(S)]XD3(S)	[D0(O)σD2(O)]/D3(S)
[D0(W)/D0(O)]/D3(S)	[D0(W)@D2(O)]/D3(S)	[D0(W)+D0(W)]/D3(S)	[D0(O)XD2(O)]XD3(S)	[D0(O)@D0(S)]/D3(S)	[D0(O)σD2(S)]XD3(S)
[D0(W)/D0(S)]XD3(S)	[D0(W)@D2(S)]XD3(S)	[D0(W)+D0(O)]XD3(S)	[D0(O)XD2(O)]/D3(S)	[D0(O)@D1(W)]XD3(S)	[D0(O)σD2(S)]/D3(S)
[D0(W)/D0(S)]/D3(S)	[D0(W)@D2(S)]/D3(S)	[D0(W)+D0(O)]/D3(S)	[D0(O)XD2(S)]XD3(S)	[D0(O)@D1(W)]/D3(S)	[D0(O)σD2(S)]/D3(S)
[D0(W)/D1(W)]XD3(S) ::	[D0(W)@D3(W)]XD3(S)	[D0(W)@D3(W)]XD3(S)	[D0(O)XD2(S)]/D3(S)	[D0(O)@D1(O)]XD3(S)	[D0(O)σD3(W)]XD3(S)
[D0(W)/D1(W)]/D3(S)	[D0(W)@D3(W)]/D3(S)	[D0(W)+D0(S)]XD3(S) ::	[D0(O)XD3(W)]XD3(S)	[D0(O)@D1(O)]/D3(S)	[D0(O)σD3(W)]/D3(S)
[D0(W)/D1(O)]XD3(S)	[D0(W)@D3(O)]XD3(S)	[D0(W)+D1(W)]XD3(S) ::	[D0(O)XD3(W)]/D3(S)	[D0(O)@D1(S)]XD3(S)	[D0(O)σD3(O)]XD3(S)
[D0(W)/D1(O)]/D3(S)	[D0(W)@D3(O)]/D3(S)	[D0(W)+D1(W)]/D3(S)	[D0(O)XD3(O)]XD3(S)	[D0(O)@D1(S)]/D3(S)	[D0(O)σD3(O)]/D3(S)
[D0(W)/D1(S)]XD3(S)	[D0(W)@D3(S)]XD3(S)	[D0(W)+D1(O)]XD3(S)	[D0(O)XD3(O)]/D3(S)	[D0(O)@D2(W)]XD3(S)	[D0(O)σD3(S)]XD3(S)
[D0(W)/D1(S)]/D3(S) ::	[D0(W)@D3(S)]/D3(S)	[D0(W)+D1(O)]/D3(S)	[D0(O)XD3(S)]XD3(S)	[D0(O)@D2(W)]/D3(S)	[D0(O)σD3(S)]/D3(S)
	[D0(W)σD0(W)]XD3(S)	[D0(W)+D1(S)]XD3(S)	[D0(O)XD3(S)]/D3(S)	[D0(O)@D2(O)]XD3(S)	[D0(O)σD3(S)]/D3(S)

The same for suspensions

<https://doi.org/10.1351/goldbook.C01177>

Suspension : A liquid in which solid particles are dispersed.

Colloidal suspension: A suspension in which the size of the particles lies in the colloidal range.

Source:

PAC, 1972, 31, 577. (Manual of Symbols and Terminology for Physicochemical Quantities and Units, Appendix II: Definitions, Terminology and Symbols in Colloid and Surface Chemistry) on page 606

Cite as: IUPAC. Compendium of Chemical Terminology, 2nd ed. (the "Gold Book"). Compiled by A. D. McNaught and A. Wilkinson. Blackwell Scientific Publications, Oxford (1997). Online version (2019-) created by S. J. Chalk. ISBN 0-9678550-9-8. <https://doi.org/10.1351/goldbook>.

Suspensions Class 1

```
A := [];  
phase := [W, O, S];  
dimension := [D0, D1, D2, D3];  
opérateur := ["X", "/", "@", "&sigma;"];  
formule := "";  
graine := "";  
for dim1 to 4 do  
  for phas1 to 3 do  
    for ope to 2 do  
      formule := cat(graine, dimension[dim1], "(", phase[phas1], ")", opérateur[ope], dimension[4], "(", phase[1], ")"); A  
      := [op(A), formule];  
    end do;  
  end do;  
end do;  
formule;  
writedata("suspensions_classe_1_ds_W_brut", A, string);
```


Here they are

D0(W)XD3(W)	D0(W)/D3(W)
D0(O)XD3(W)	D0(O)/D3(W)
D0(S)XD3(W)	D0(S)/D3(W)
D1(W)XD3(W)	D1(W)/D3(W)
D1(O)XD3(W)	D1(O)/D3(W)
D1(S)XD3(W)	D1(S)/D3(W)
D2(W)XD3(W)	D2(W)/D3(W)
D2(O)XD3(W)	D2(O)/D3(W)
D2(S)XD3(W)	D2(S)/D3(W)
D3(W)XD3(W)	D3(W)/D3(W)
D3(O)XD3(W)	D3(O)/D3(W)
D3(S)XD3(W)	D3(S)/D3(W)

Suspensions Class 2

```

A := [];

dimension := [D0, D1, D2, D3];

phase := [W, O, S];

opérateur := ["X", "/", "@", "&sigma;", "+"];

formule := "";

graine := "";

for dim1 to 4 do

for phas1 to 3 do

for ope1 to 5 do

for dim2 to 4 do

for phas2 to 3 do

for ope2 to 2 do

if ope1 <> opérateur[2] then formule := cat(graine, "[", dimension[dim1], "(", phase[phas1], ")", opérateur[ope1], dimension[dim2], "(", phase[phas2], ")", "]", opérateur[ope2], "D3(S)"); A := [op(A), formule];

end if;

end do;

end do;

end do;

end do;

end do;

end do;

end do;

writedata("liste deux phases trois objets", A, string);

```

The result : 362 systems

[D0(G) @ D0(S)] / D3(L)
 [D0(G) @ D1(S)] / D3(L)
 [D0(G) @ D2(S)] / D3(L)
 [D0(G) @ D3(S)] / D3(L)
 [D0(G) / D0(S)] / D3(L)
 [D0(G) / D1(S)] / D3(L)
 [D0(G) / D2(S)] / D3(L)
 [D0(G) / D3(S)] / D3(L)
 [D0(G) + D0(S)] / D3(L)
 [D0(G) + D1(S)] / D3(L)
 [D0(G) + D2(S)] / D3(L)
 [D0(G) + D3(S)] / D3(L)
 [D0(G) s D0(S)] / D3(L)
 [D0(G) s D1(S)] / D3(L)

[D0(G) s D2(S)] / D3(L)
 [D0(G) s D3(S)] / D3(L)
 [D0(G) X D0(S)] / D3(L)
 [D0(G) X D1(S)] / D3(L)
 [D0(G) X D2(S)] / D3(L)
 [D0(O) @ D0(S)] / D3(L)
 [D0(O) @ D1(S)] / D3(L)
 [D0(O) @ D2(S)] / D3(L)
 [D0(O) @ D3(S)] / D3(L)
 [D0(O) / D0(S)] / D3(L)
 [D0(O) / D1(S)] / D3(L)
 [D0(O) / D2(S)] / D3(L)
 [D0(O) / D3(S)] / D3(L)

[D0(G) s D2(S)] / D3(L)
 [D0(G) s D3(S)] / D3(L)
 [D0(G) X D0(S)] / D3(L)
 [D0(G) X D1(S)] / D3(L)
 [D0(G) X D2(S)] / D3(L)
 [D0(O) @ D0(S)] / D3(L)
 [D0(O) @ D1(S)] / D3(L)
 [D0(O) @ D2(S)] / D3(L)
 [D0(O) @ D3(S)] / D3(L)
 [D0(O) / D0(S)] / D3(L)
 [D0(O) / D1(S)] / D3(L)
 [D0(O) / D2(S)] / D3(L)
 [D0(O) / D3(S)] / D3(L)

etc

There are other possibilities

Classes of higher orders

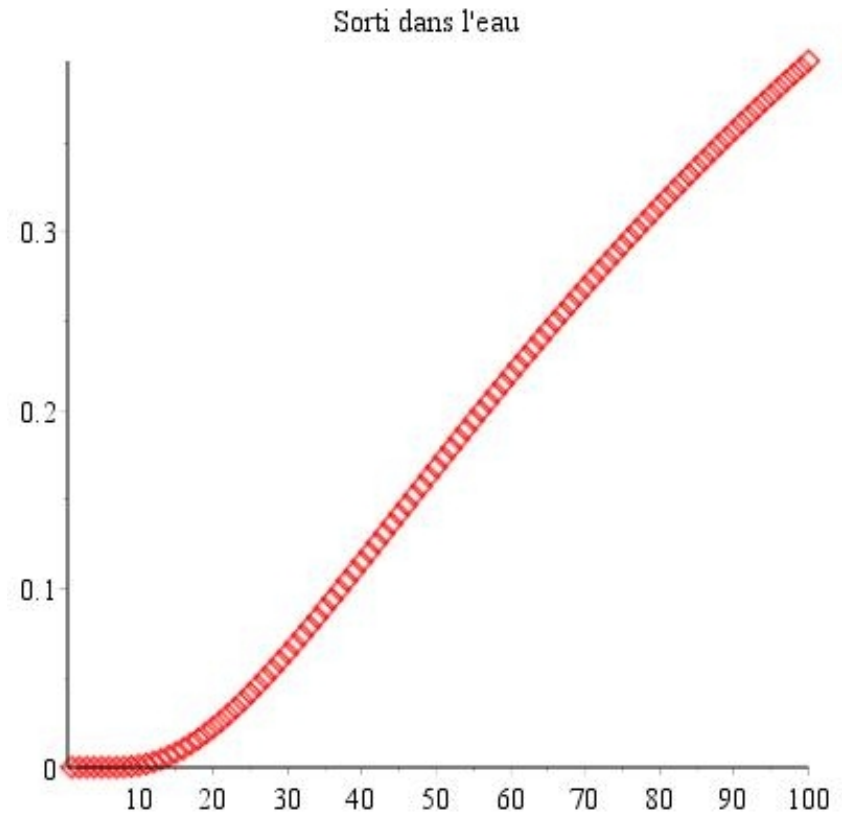
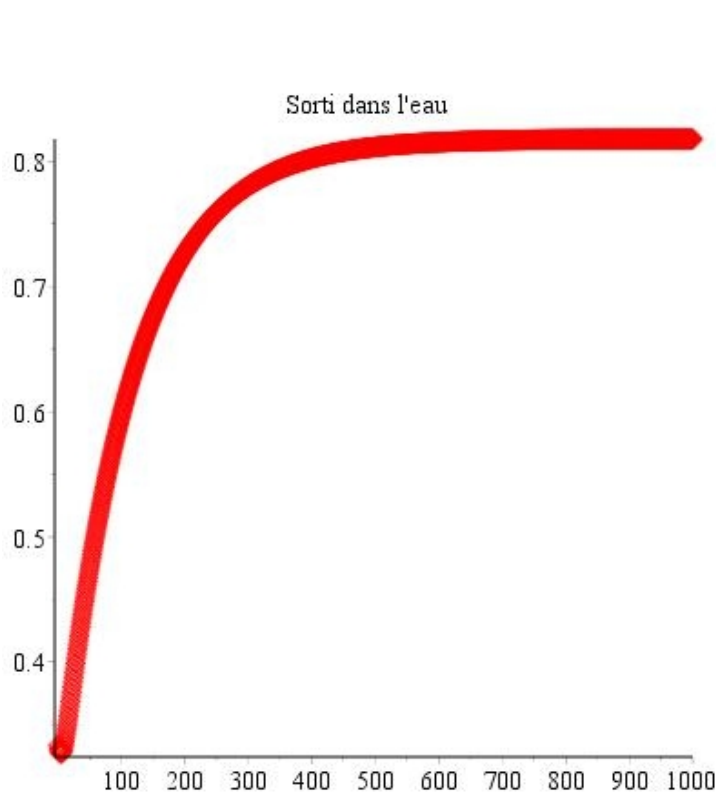
Suspensions in foams

Suspensions in emulsions

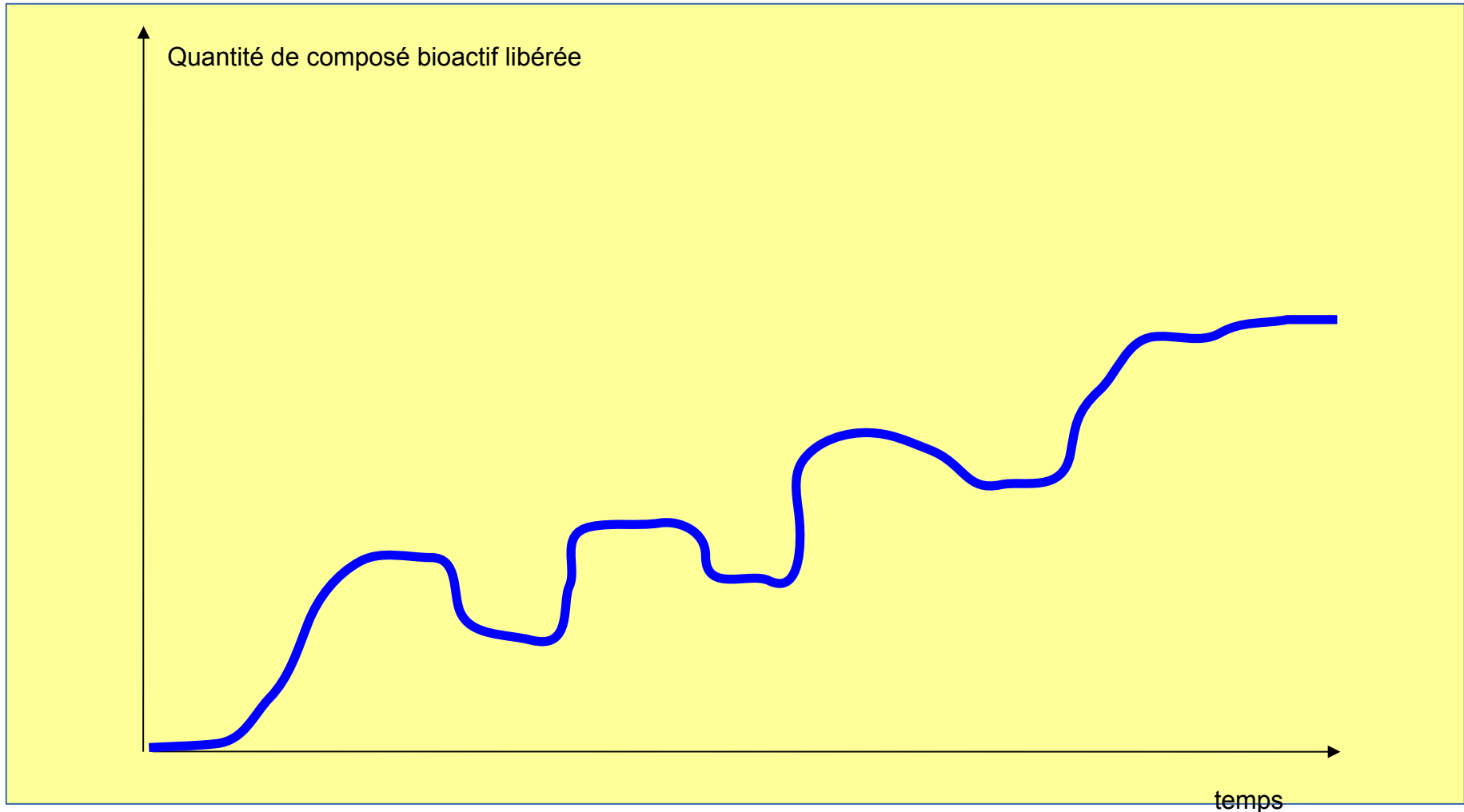
Suspensions in gels

With the same code

Different “bioactivities”



Can we do this ?

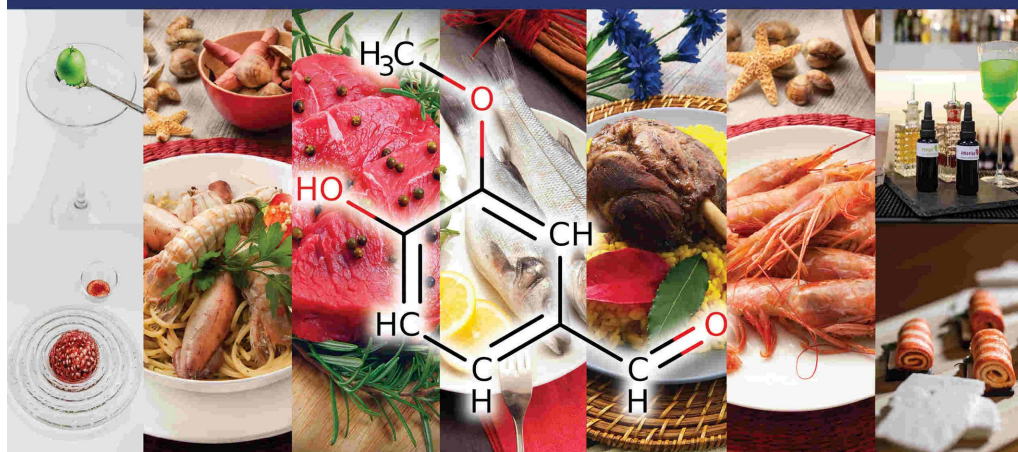


Yes



HANDBOOK OF MOLECULAR GASTRONOMY

Scientific Foundations, Educational Practices,
and Culinary Applications



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Celebrate chemistry (but there was more physics here)



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