Universe 2021 WEBINARS

keV Warm Dark Matter in Agreement with Observations in Tribute to Héctor J. De Vega

10 NOVEMBER 2021, 1:30 PM (CET)

MDPI WEBINARS

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Relevant Universe Special Issue:

keV Warm Dark Matter (ΛWDM) in Agreement with Observations in Tribute to Héctor J. de Vega

Guest Editor: Prof. Dr. Norma G. Sanchez

Deadline for manuscript submissions:

30 November 2021

Many Ongoing WDM Directions of Research :

- Particle Models, Sterile neutrinos, Production mechanisms. WDM decay
- Experimental searches.

- WDM Numerical Simulations: structure formation
-Constraints on WDM m_x, mvs: Analytical, numerical, small scales, velocity dispersions

- WDM Astrophysics & Cosmological: reionization, 21 cm line, prospects for SKA. High z supernova lensing, HST, JWST, WDM Star Formation, WDM Galactic BHs

- WDM CMB: WDM decay, CMB Spectrum distortions, ...

WARM DARK MATTER REPRODUCE

→OBSERVED GALAXY DENSITIES AND VELOCITY DISPERSIONS

→SOLVES the OVERABUNDANCE (“satellite) PROBLEM

->OBSERVED SURFACE DENSITY VALUES OF DARK MATTER DOMINATED GALAXIES

→OBSERVED GALAXY CORED DENSITY PROFILES : QUANTUM MECHANICS

• WDM OVERALL CONCLUSION

- To conclude, we find it is highly remarkable that in the context of warm dark matter, the quantum description provided by this semiclassical framework, (quantum WDM and classical gravitation), is able to reproduce such broad variety of galaxies.

- The resulting galaxy, halo radius, galaxy masses and velocity dispersion are fully consistent with observations for all different types of galaxies. Fermionic WDM treated quantum mechanically, as it must be, is able to reproduce the observed galactic cores and their sizes. In addition, WDM simulations produce the right DM structures in agreement with observations for scales > kpc.

WDM + BARYONS

Baryons have not been included in this study. This is fully justified because on one hand dwarf compact galaxies are composed today 99.99 % of DM, and on the other hand the baryon fraction in large galaxies can reach values up to 1 - 3 %.

Since Fermionic WDM by itself produces galaxy main properties and structures in agreement with observations for all types of galaxies, masses and sizes, the effect of including baryons is expected to be a small correction to these pure WDM galaxy structural results, consistent with the fact that dark matter is in average six times more abundant than baryons.

DARK MATTER FIRMELY EXISTS WITH
A VERY CLEAR MODEL INDEPENDENT STATUS
FROM LSS and SSS OBSERVATIONS:

NO CDM : DARK MATTER IS NOT COLD (nor GeV DM , nor TeV DM…)
NO WIMPs DM NO ANNIHILATING DM (wimps would exist but not as DM). NO SELF-INTERACTING DM (which is a variation of CDM)

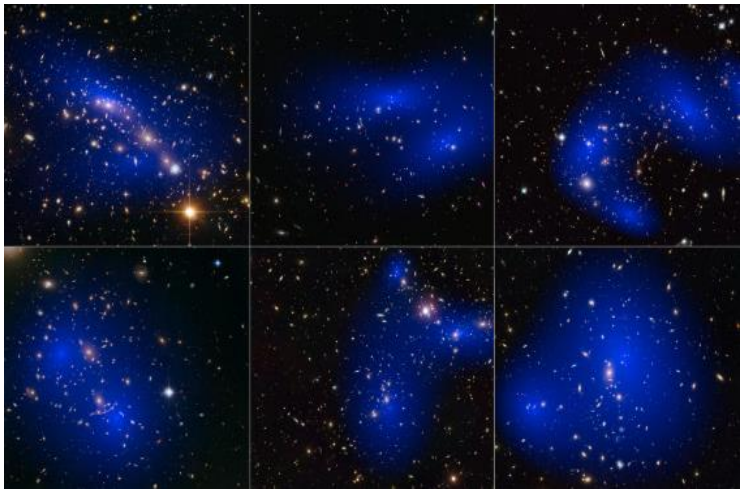
DM IS WARM: keV scale mass: O(keV) means between 2 and 9 keV

DM is FERMIONIC. DM is a Fermion with mass in the keV scale
Therefore, the QUANTUM aspects of DM must be taken into account

MANY PARTICLE PHYSICS CANDIDATES: eg keV Sterile Neutrino
GRAVITATION IS NEWTONIAN IN GALAXIES and GR in the LSS UNIVERSE. EXTENSION OF GRAVITY at the PLANCK SCALE but NOT at LARGE SCALES.

Self-interacting dark matter becames disfavored

Dark matter even darker than once thought



Hubbleinteracts with itself even less than previously & Chandra show that dark matter thought, and narrow down the options for what dark matter might be.

Good News for WDM

(« Options to CDM »: WDM and self-interacting DM)

The non-gravitational interactions of dark matter in colliding galaxy clusters

David Harvey, Richard Massey, Thomas Kitching, Andy Taylor, Eric Tittley

Science, 2015

→ Collisions between galaxy clusters provide a test of the non-gravitational forces acting on dark matter.

Previously: Dark matter's lack of deceleration in the 'bullet cluster collision' constrained its Self-interaction DM cross-section $/m < 1.25\ cm^2/g$ (68% CL)

→ Using the Chandra and Hubble Space Telescopes 72 collisions have now been observed. Combining these measurements statistically, imply :

1. The existence of dark mass at 7.6 sigma significance.
2. Self-interaction DM cross-section $/m < 0.47\ cm^2/g$ (95% CL)

→ strongly disfavoring the proposed self-interacting DM models

30 systems, mostly between redshift $0.2 < z < 0.6$
plus two at $z > 0.8$,
containing 72 pieces of structure in total

The EXISTENCE of DARK MATTER is Reaffirmed:

Observations that do not presuppose the existence of dark matter show that clusters of galaxies with $10^{14}\ M_{sun}$

contain only 3.2% of their mass in the form of stars.

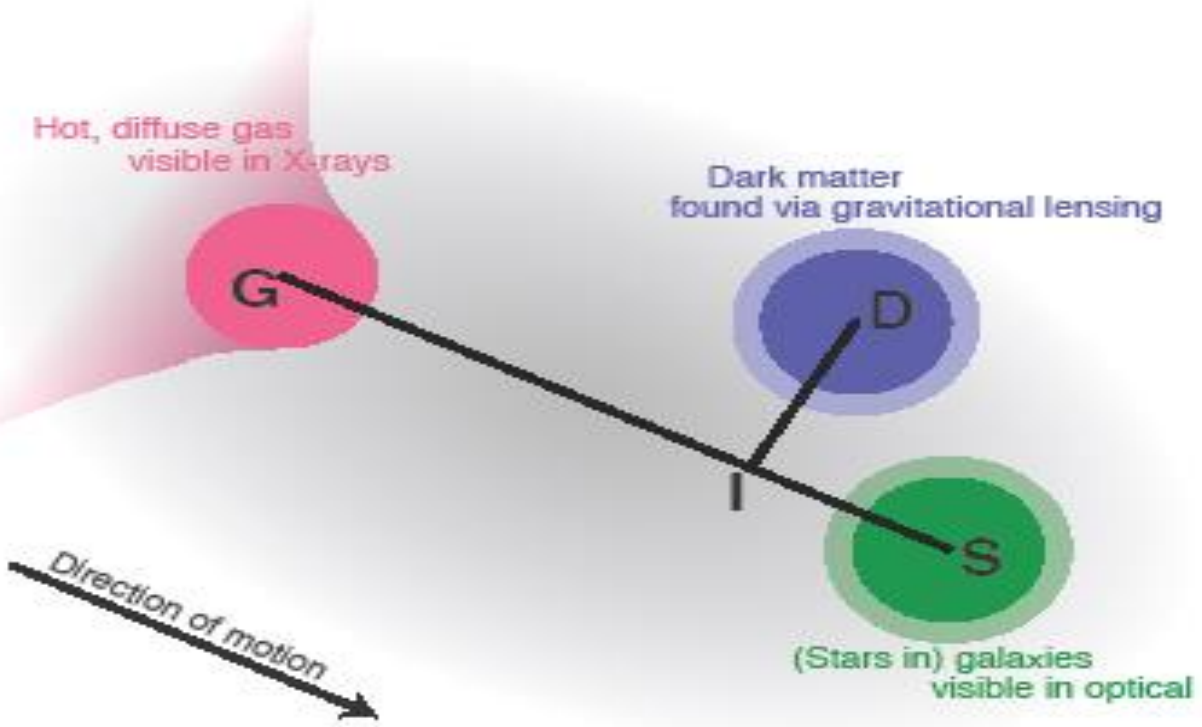


Figure 1: Cartoon showing the three components in each piece of substructure, and their relative offsets, illustrated by black lines. The three components remain within a common gravitational potential, but their centroids become offset due to the different forces acting on them, plus measurement noise. We assume the direction of motion to be defined by the vector from the diffuse, mainly hydrogen gas (which is stripped by ram pressure) to the galaxies (for which interaction is a rare event). We then measure the lag from the galaxies to the gas $\delta_{\rm SG}$, and to the dark matter in a parallel $\delta_{\rm SI}$ and perpendicular $\delta_{\rm DI}$ direction.

Le suivi d'une collision galactique au moyen du Très Grand Télescope de l'ESO et du Télescope Spatial Hubble du consortium NASA/ESA a permis de collecter des informations sur la matière noire.

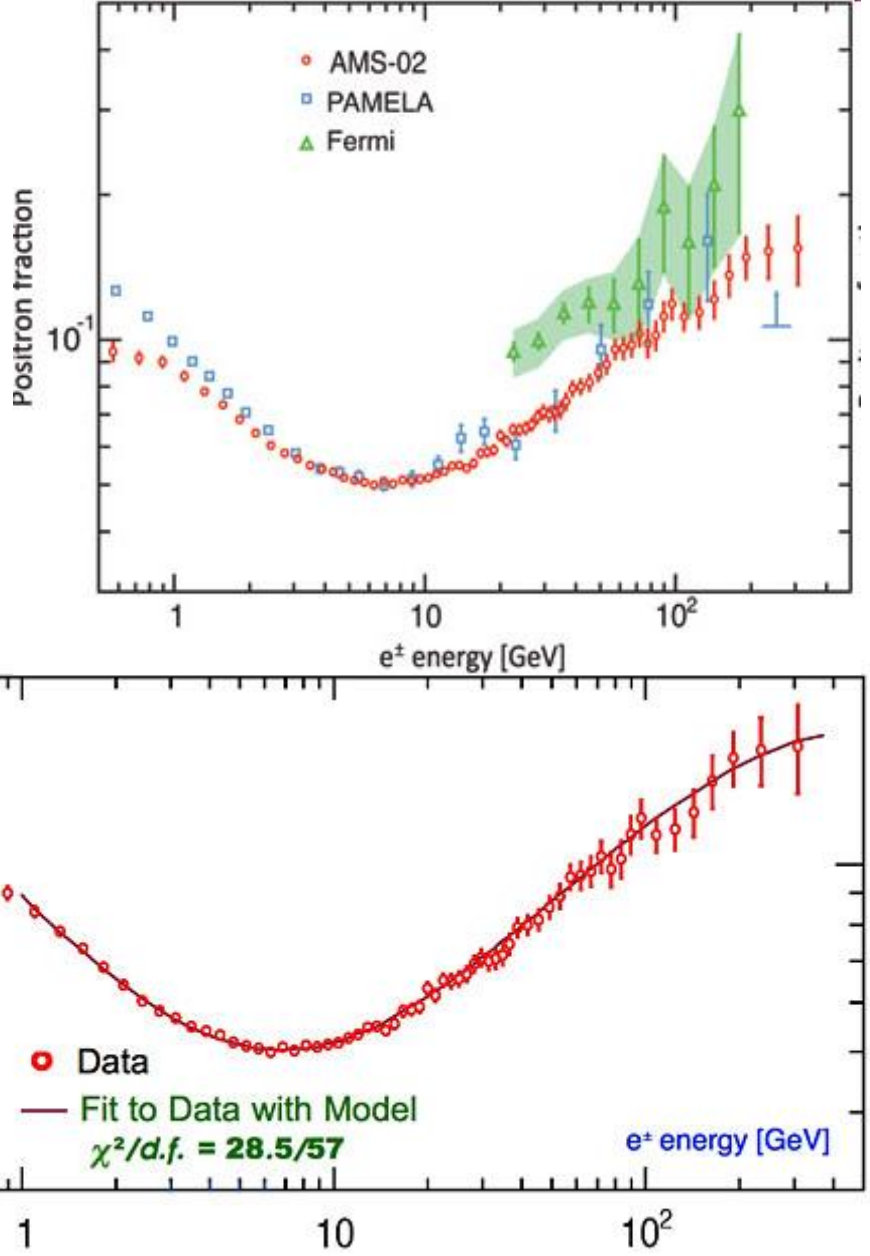
En combinant les données duVLT de l'ESO au Chili aux images acquises par le télescope spatial Hubble, la collision simultanée de quatre galaxies au sein de l'amas Abell 3827 a été étudiée.

Elle a notamment été en mesure de localiser la matière contenue au sein de ce système et de comparer la distribution de matière noire aux positions occupées par les galaxies lumineuses.

A SUIVRE….

ANTIMATTER IN SPACE - AMS on board ISS Alpha Magnet Spectrometer

NASA



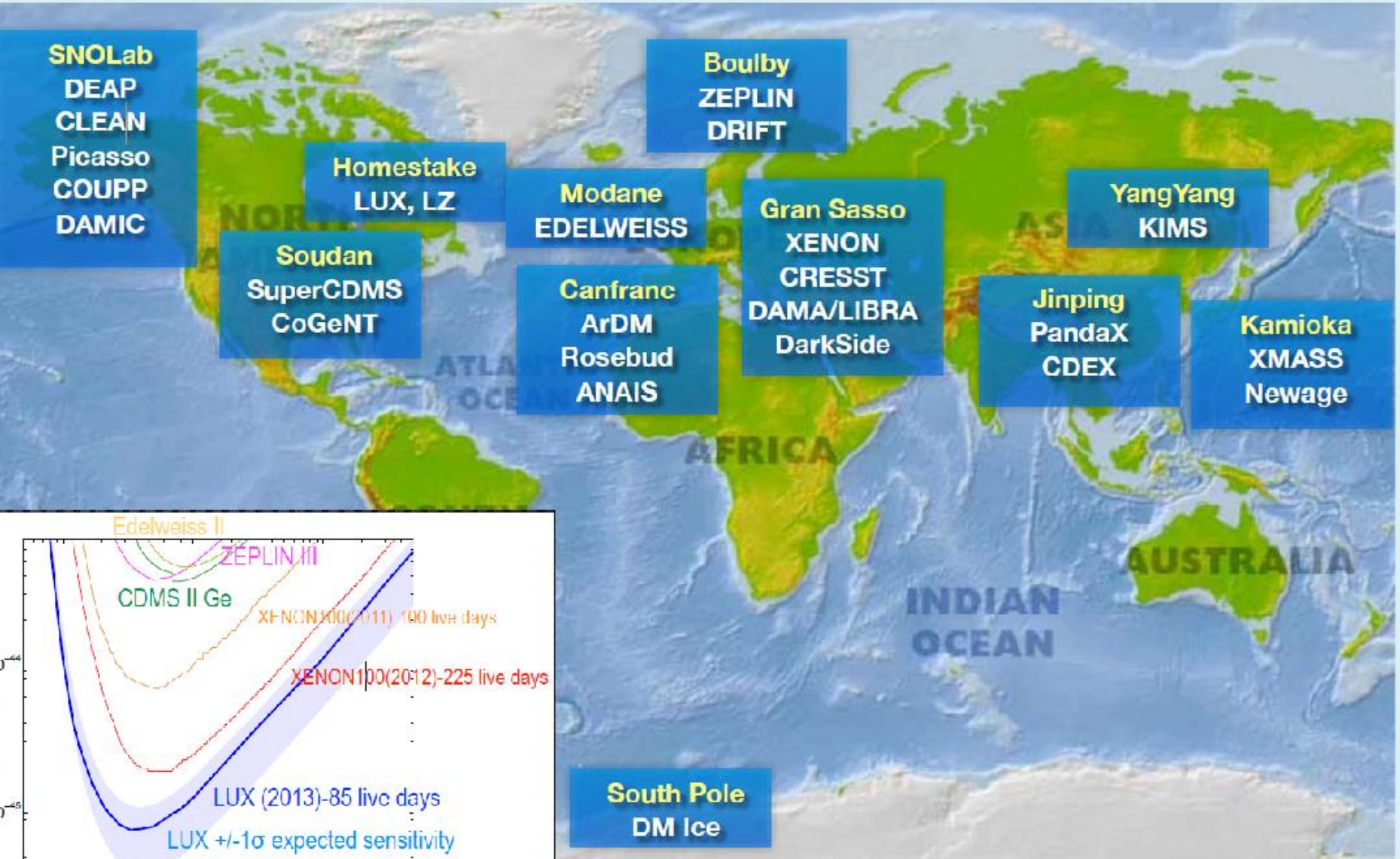
Positron excess in cosmic rays are not related to DM physics but to astrophysical sources and astrophysical mechanisms and can be explained by them

- **Why No Experimental Detection of the DM particle has been reached so far ?**

Because:

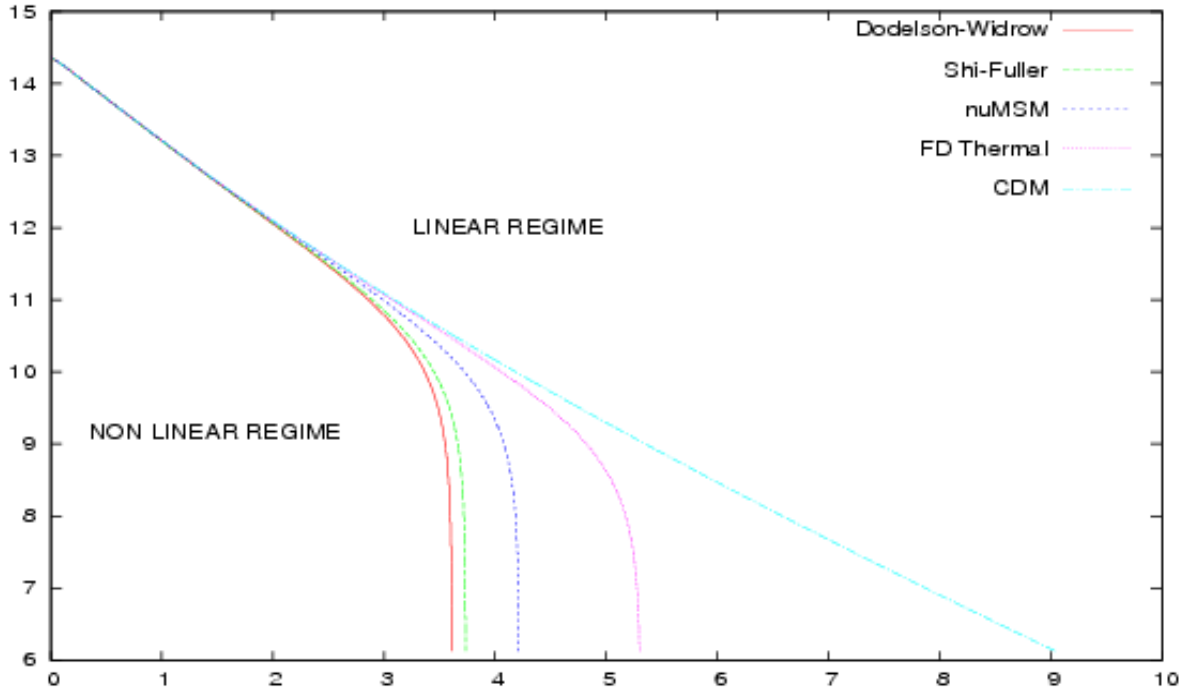
- **Most of experimental searches for DM particles are dedicated to CDM: wimps of m > 1 GeV,**
- **While the DM particle mass is in the keV scale .**
- **Moreover, past, present and future reports of signals of such CDM experiments cannot be due to DM because of the same reason.**
- **The inconclusive signals in such experiments should be originated by phenomena of other kinds.**
- **In addition, such signals contradict each other supporting the idea that they are unrelated to any DM detection.**

Dans le monde entier



Linear and non-linear regimes in z and R

$\sigma^2(R,z) \sim 1$: borderline between linear and non-linear regimes. Objects (galaxies) of scale R and mass $\sim R^3$ start to form when this scale becomes non-linear.
Smaller objects can form earlier.



$\sigma^2(M,z) = 1$ in the $z,\ \log[h\ M/M_\odot]$ plane for $m = 2.5$ keV in four different WDM models and in CDM.

Constraining the Warm Dark Matter Particle Mass

through Ultra-Deep UV Luminosity Functions at high z from the HST Frontier Field

Comparing the predicted and the measured abundance of the faintest galaxies : $m_x > \sim O(keV)$

The corresponding lower limit for sterile neutrinos depends on the production mechanism: $m_{sterile} \gtrsim 0$ (keV).

As a baseline for forthcoming observations from the HST Frontier Field :predictions for the abundance of faint galaxies for different values of $m_x \sim 0$(keV) valid for high z.

N. Menci, et al, ApJ 2016 , 2017, 2018 ...

Exciting keV Warm Dark Matter

work to perform is ahead of us

and Detection !

https://www.mdpi.com/journal/universe/special_issues/kWDM

THANK YOU FOR YOUR ATTENTION

WELCOME To The NEXT WEBINAIRE

WEDNESDAY 17 NOVEMBER 2021

13h30 CET

- *Science is built up with facts,*
- *as a house is with stones.*
- *But a collection of facts is no more a science*
- *than a heap of stones is a house.*

-- Henri Poincaré

- *La science est construit avec des faits,*
- *ainsi comme une maison est construite*
- *avec des pierres.*
- *Mais une collection de faits n'est pas une science, ainsi comme un tas de pierres n'est pas une maison.*