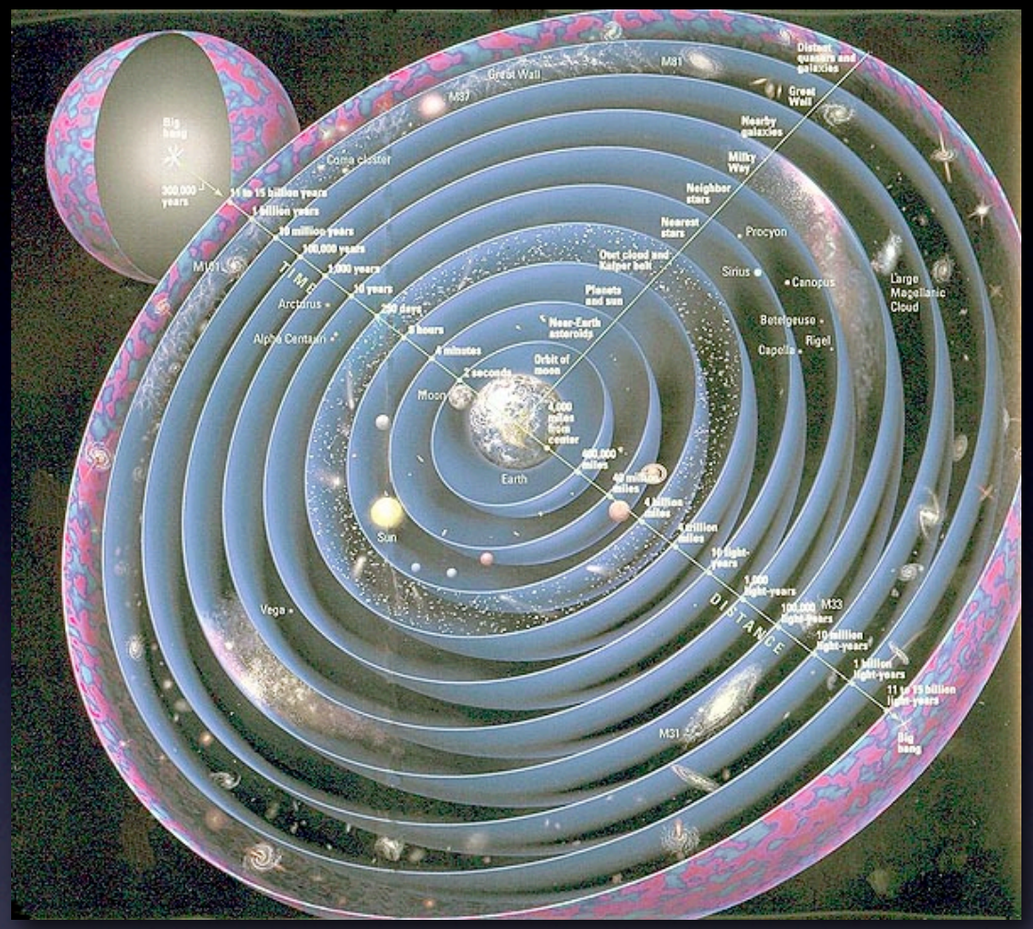
Cosmologie et Supernovae de Type Ia

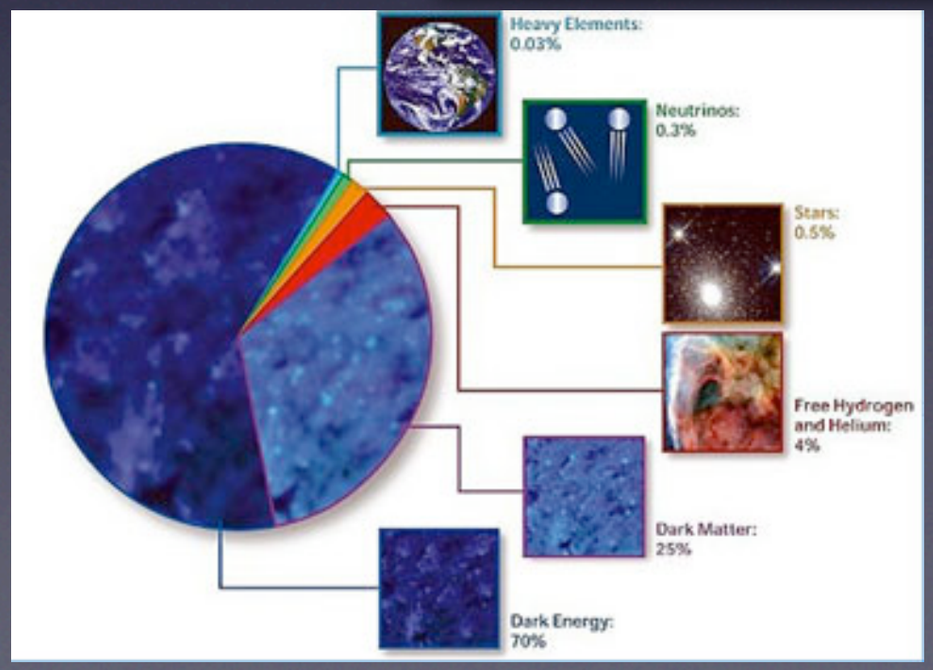
Sébastien "Ze Frog" Bongard

La Cosmologie observationelle

Où l'on s'intéresse essentiellement à Rien...

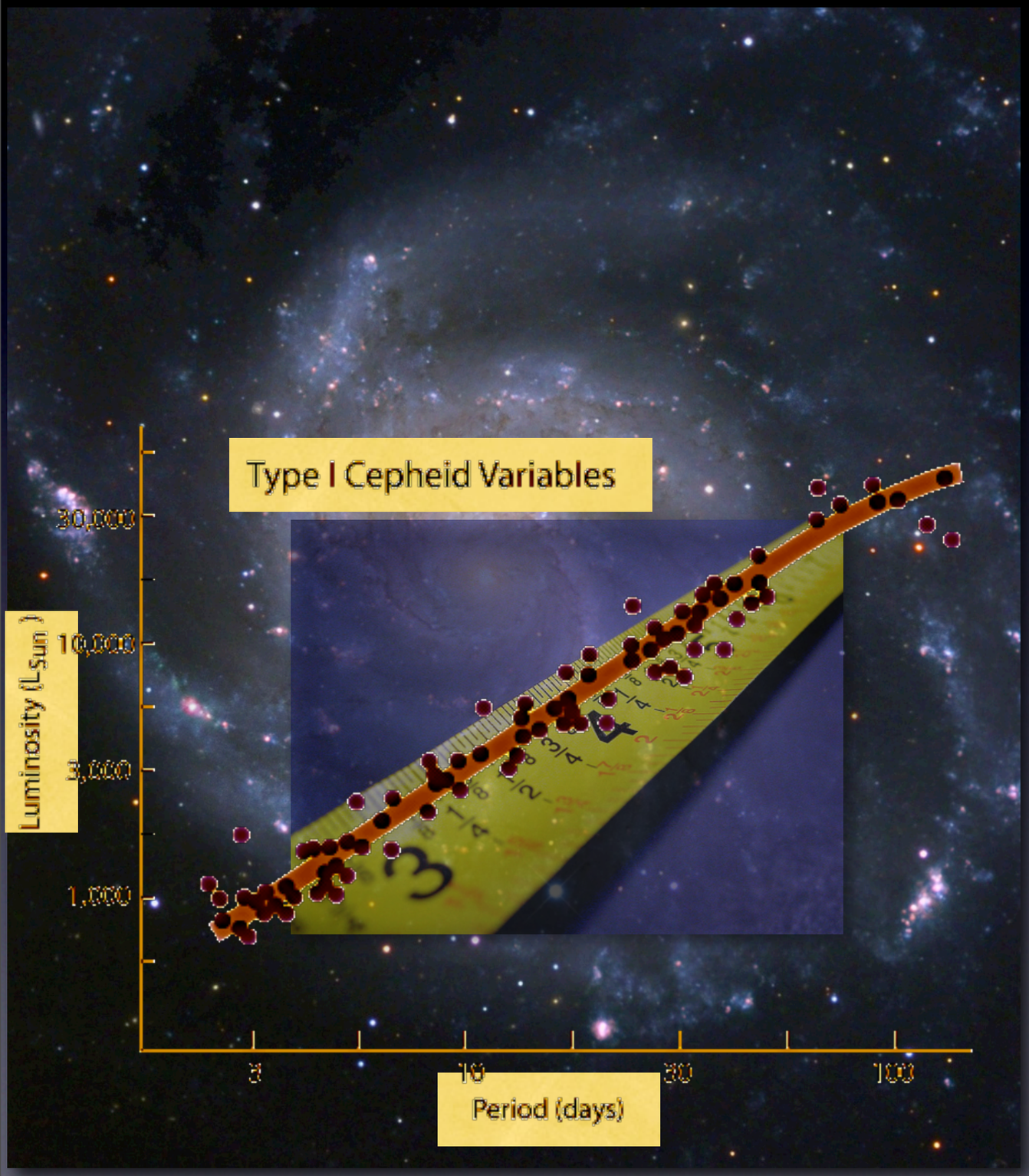


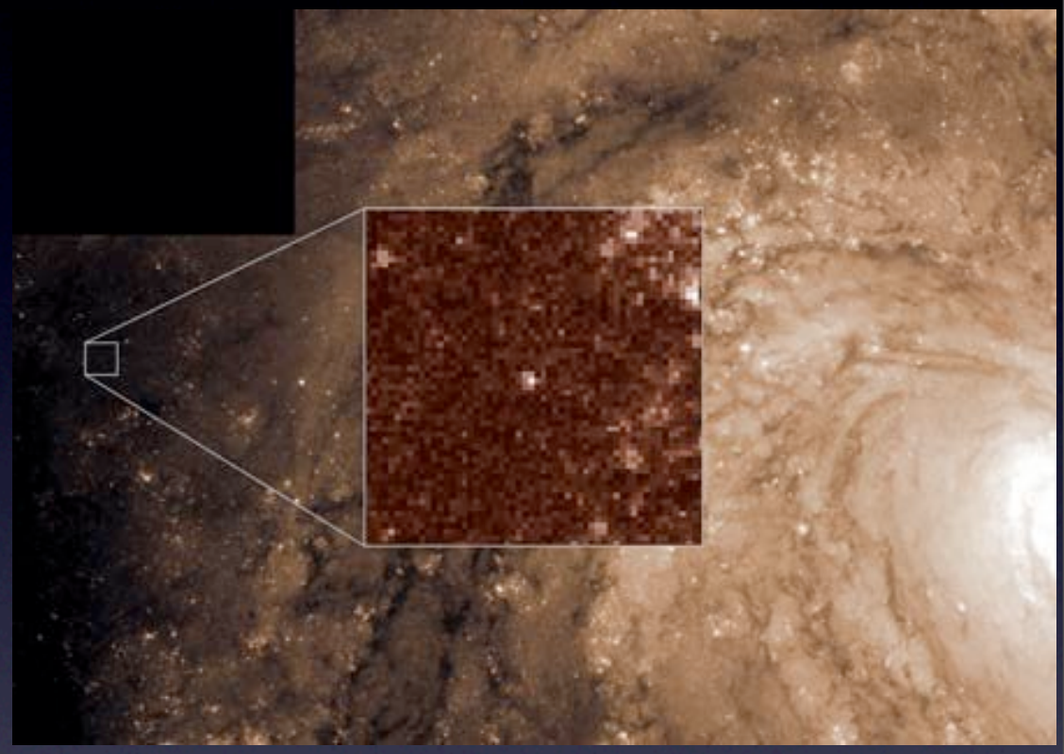
... qui est essentiellement composé d'énergie



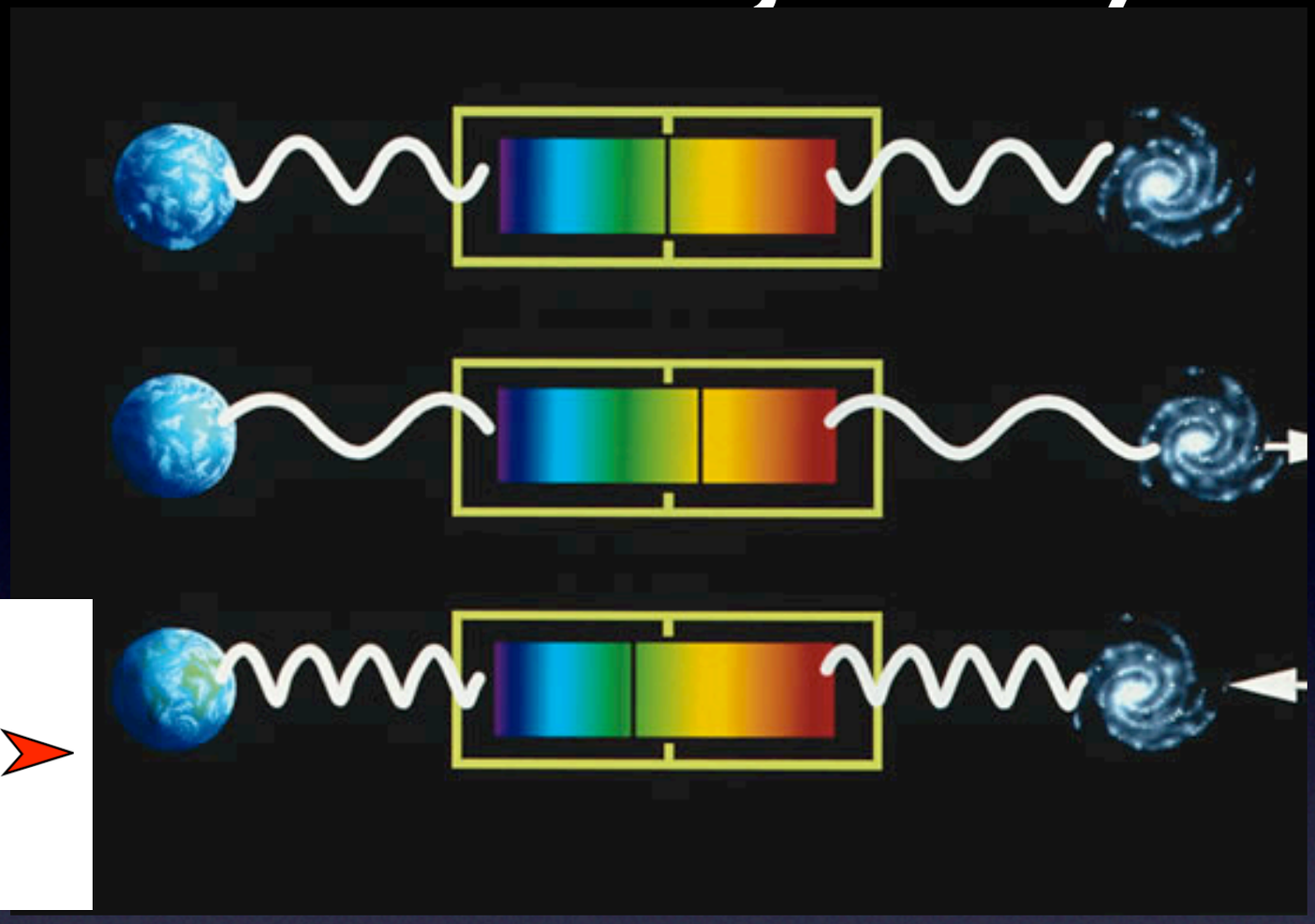
Pour étudier Rien, on le mesure...

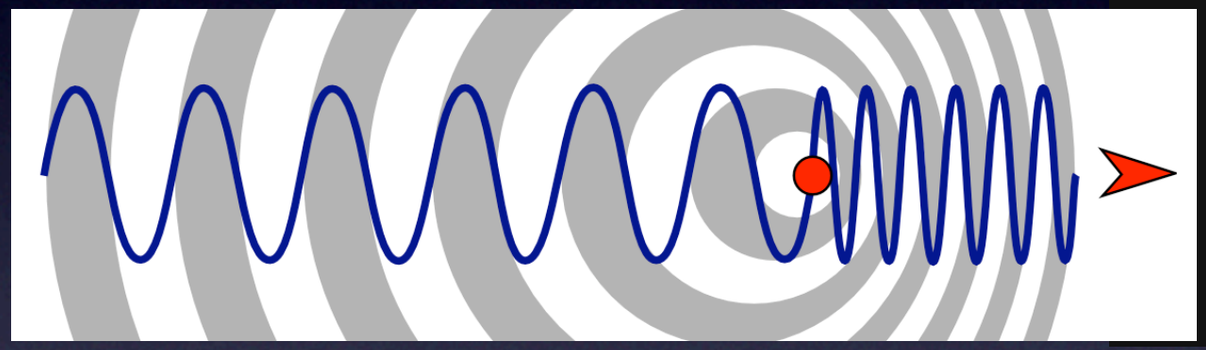
...Avec ce qu'il y a dedans





Et on étudie comment les objets s'y déplacent



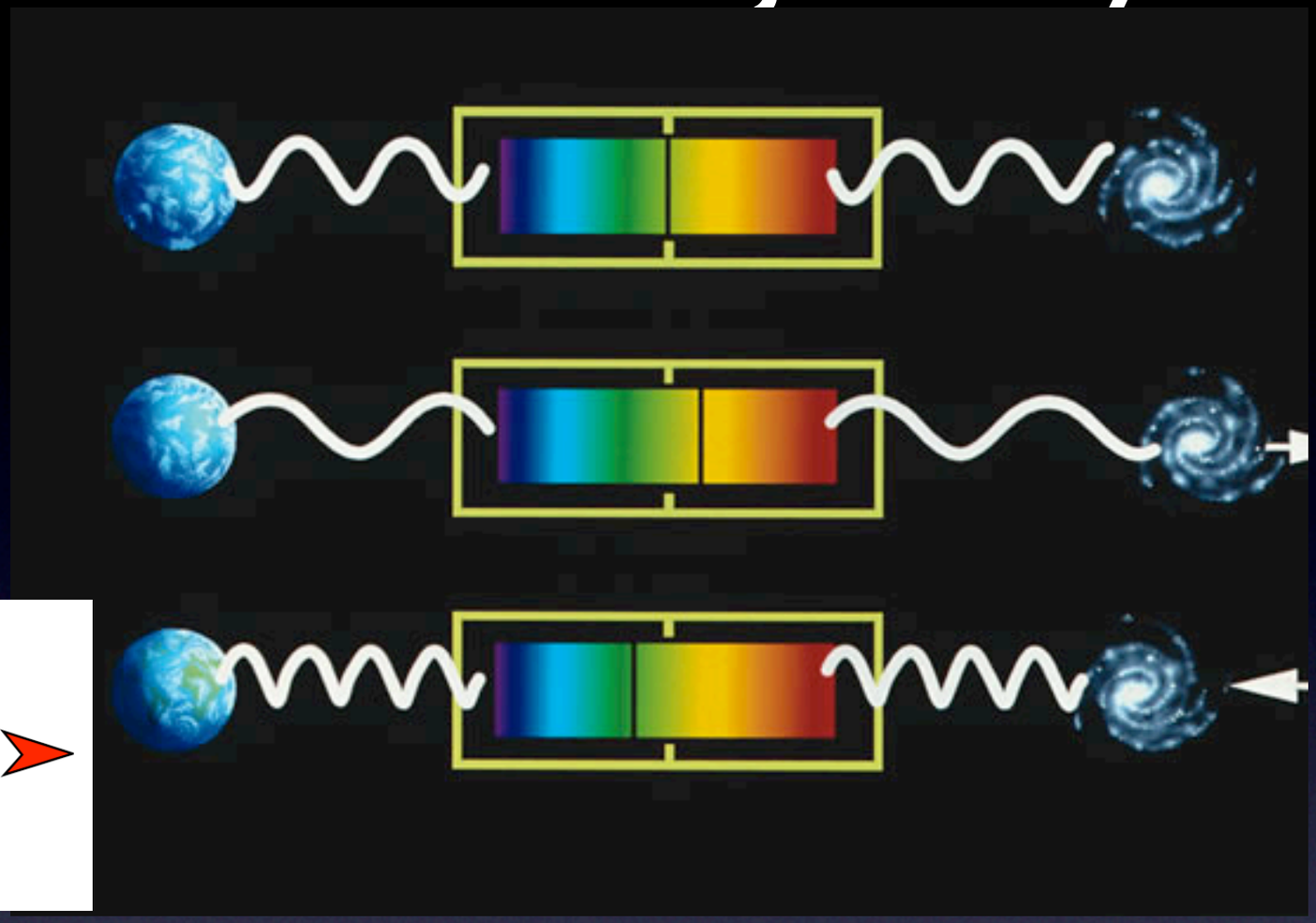


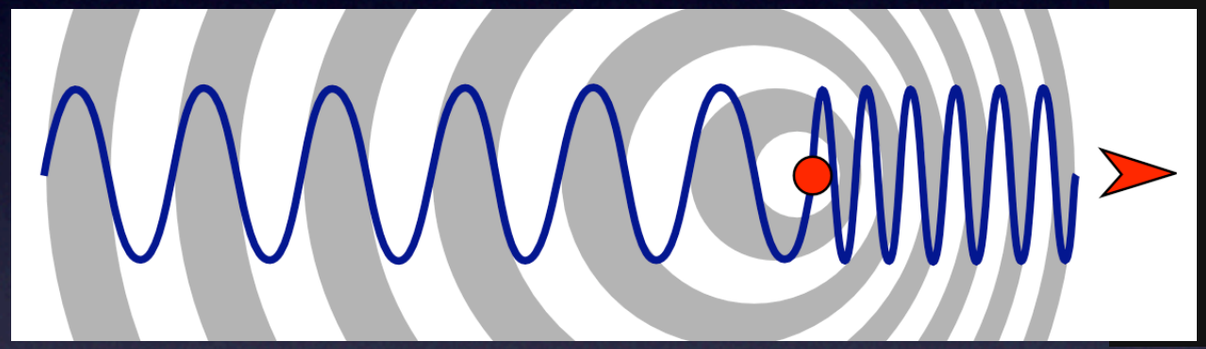
Décalage vers le rouge

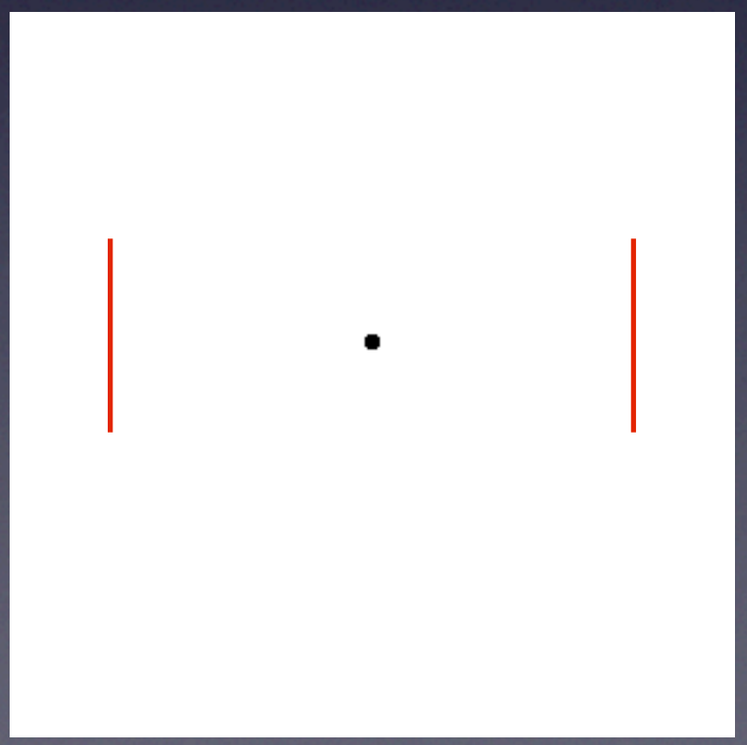
$$\frac{\Delta\lambda}{\lambda_0} \sim \frac{\Delta v}{c}$$

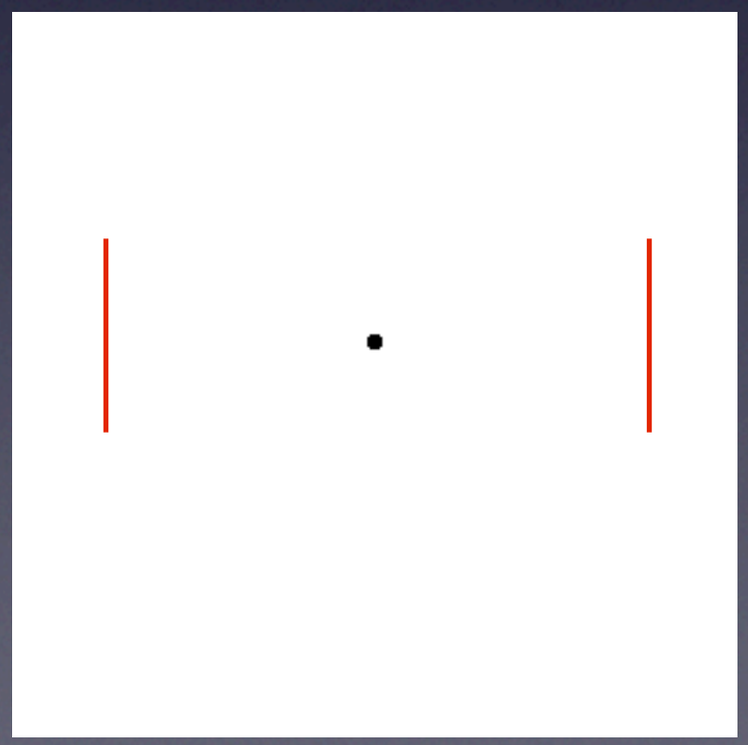
Vitesse d'éloignement

Et on étudie comment les objets s'y déplacent









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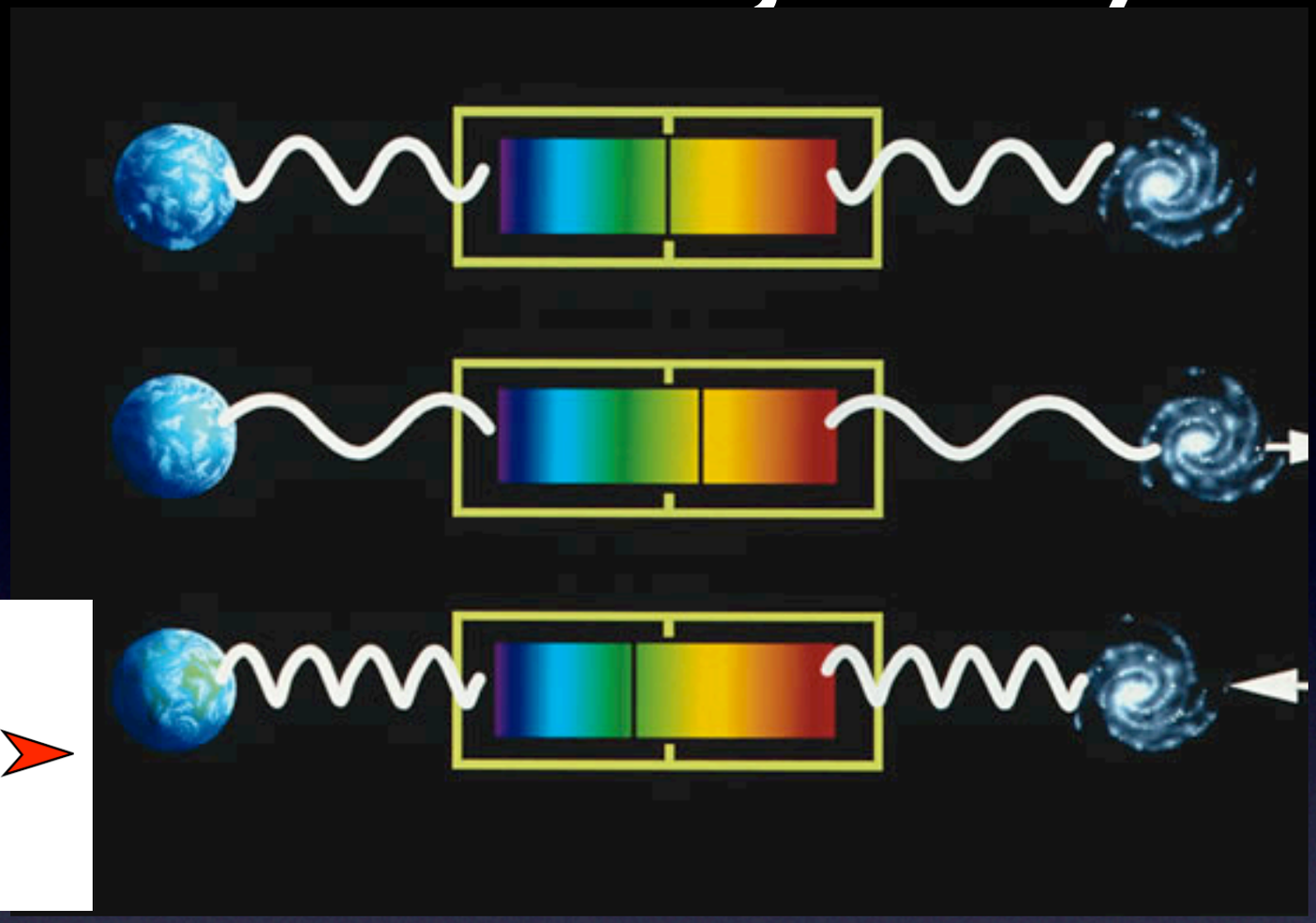
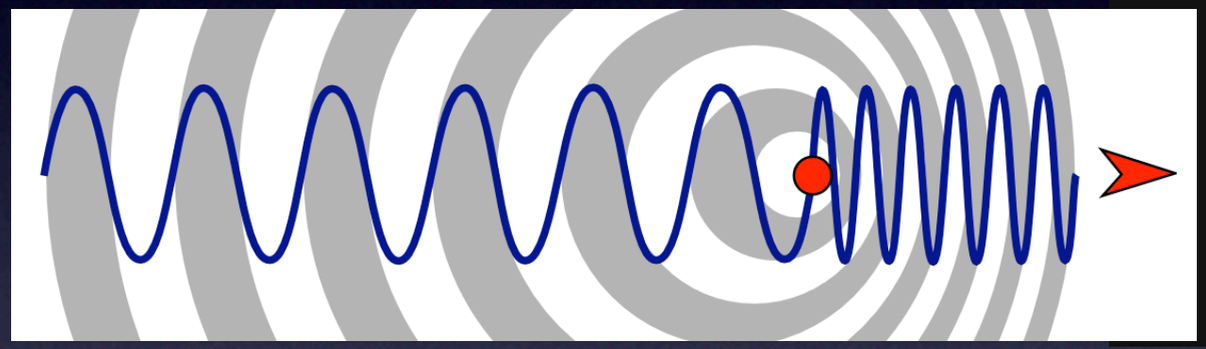
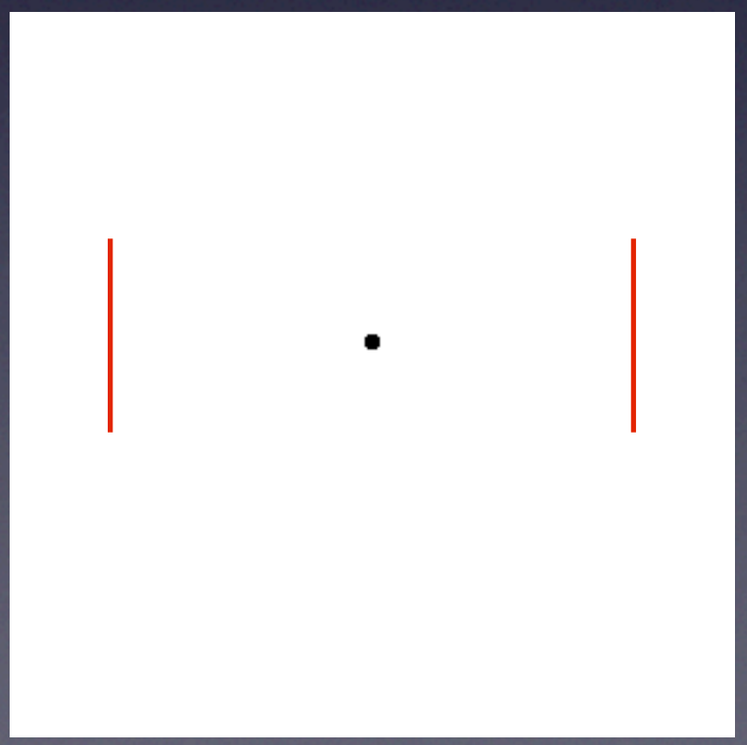
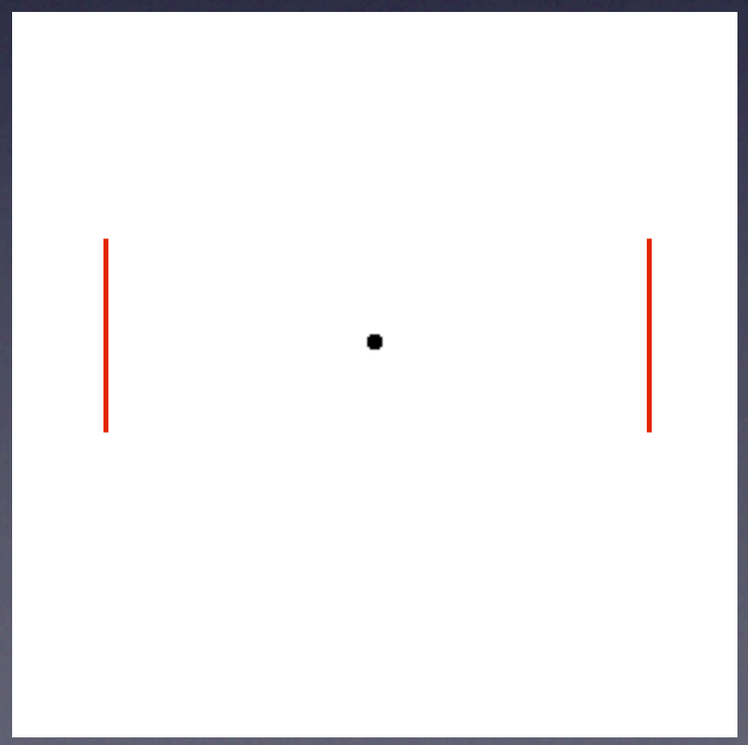






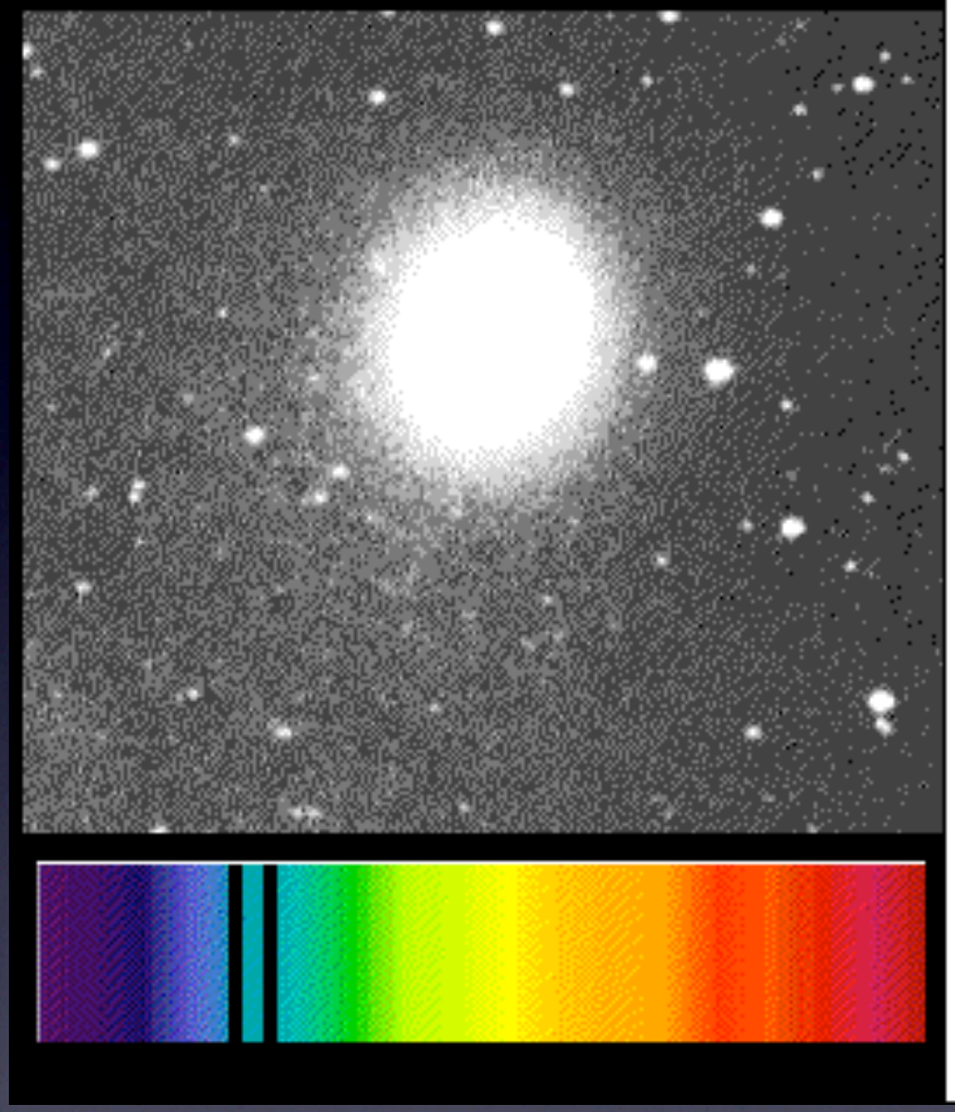


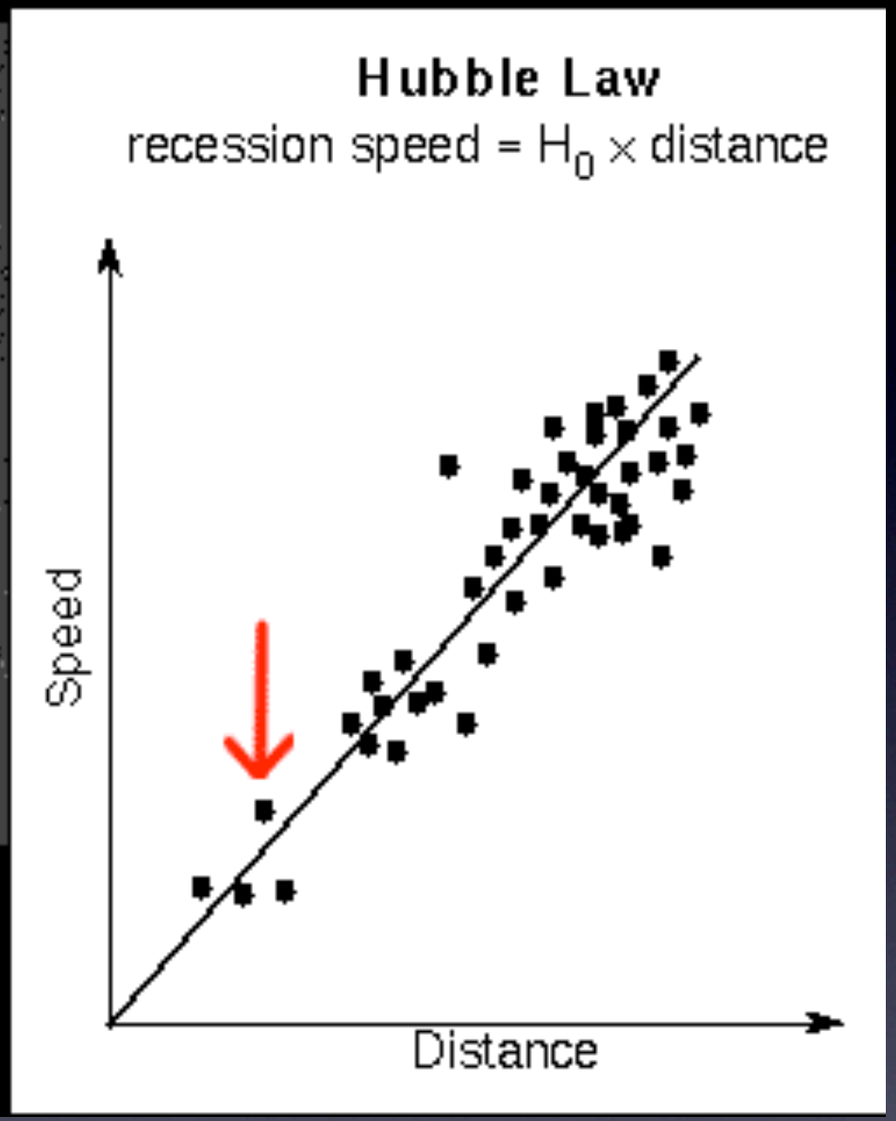
Décalage vers le rouge

$$\frac{\Delta\lambda}{\lambda_0} \sim \frac{\Delta v}{c}$$

Vitesse d'éloignement

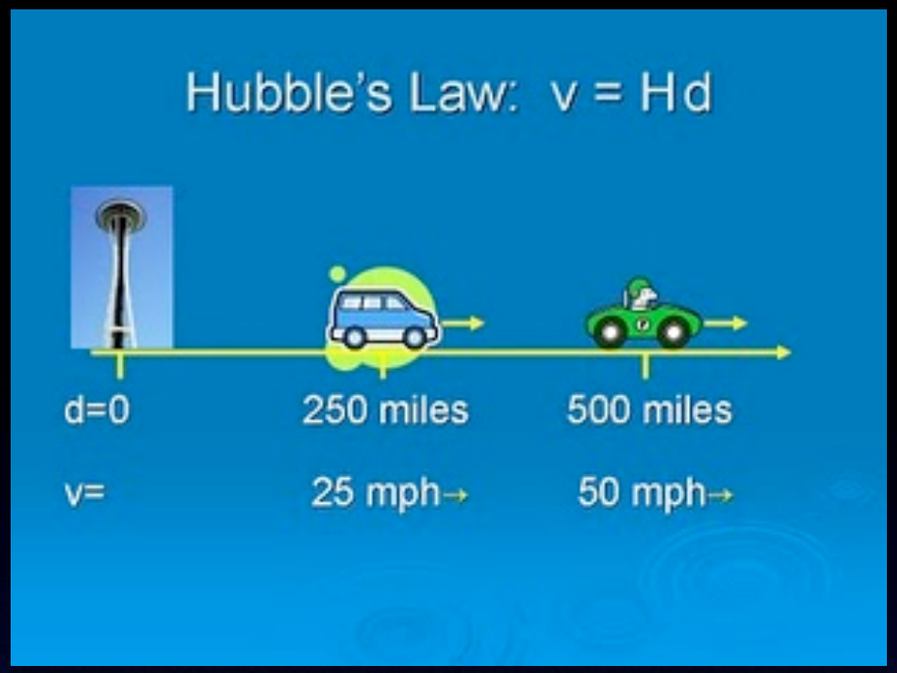
Plus les galaxies sont loin...

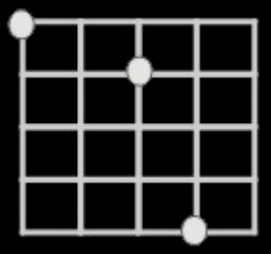


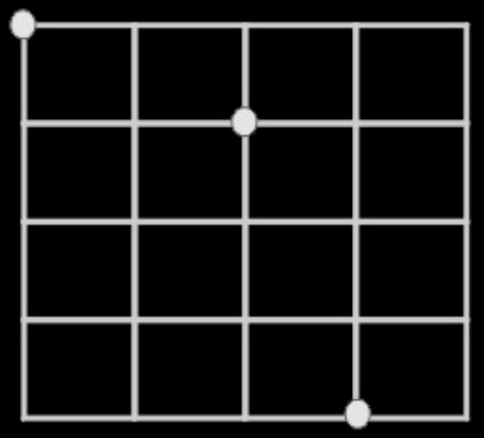


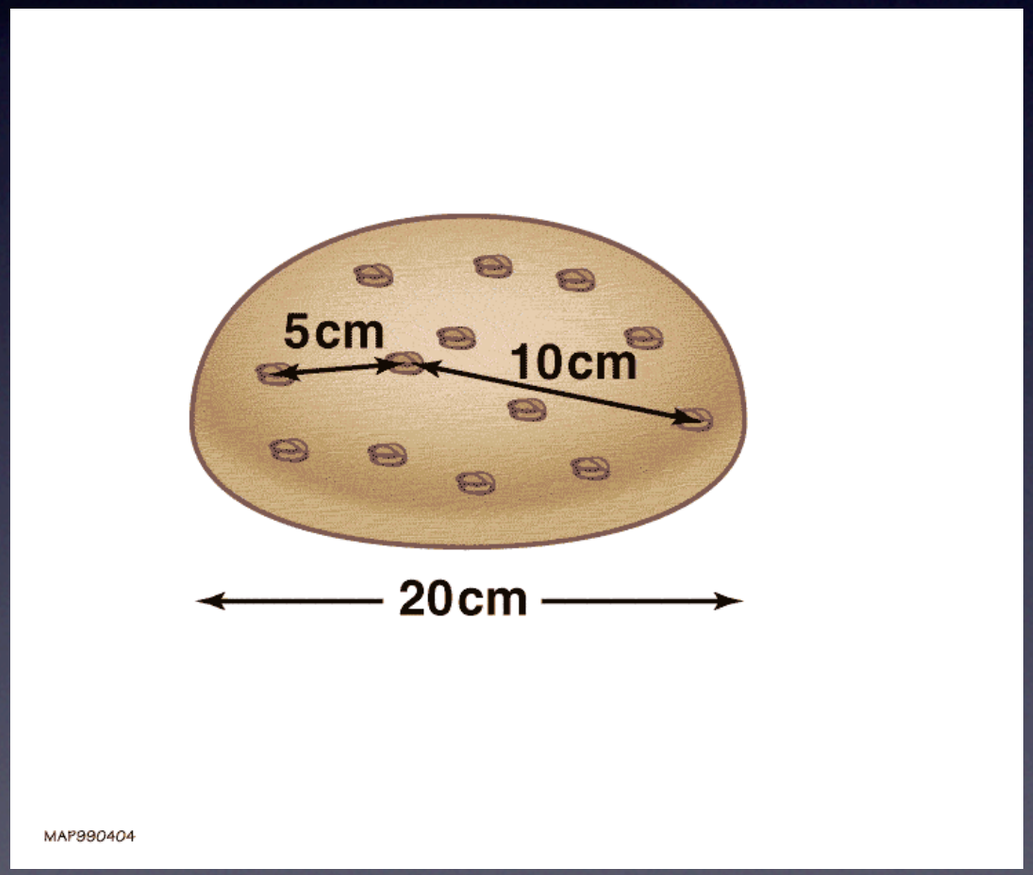
... Plus elles s'éloignent vite.

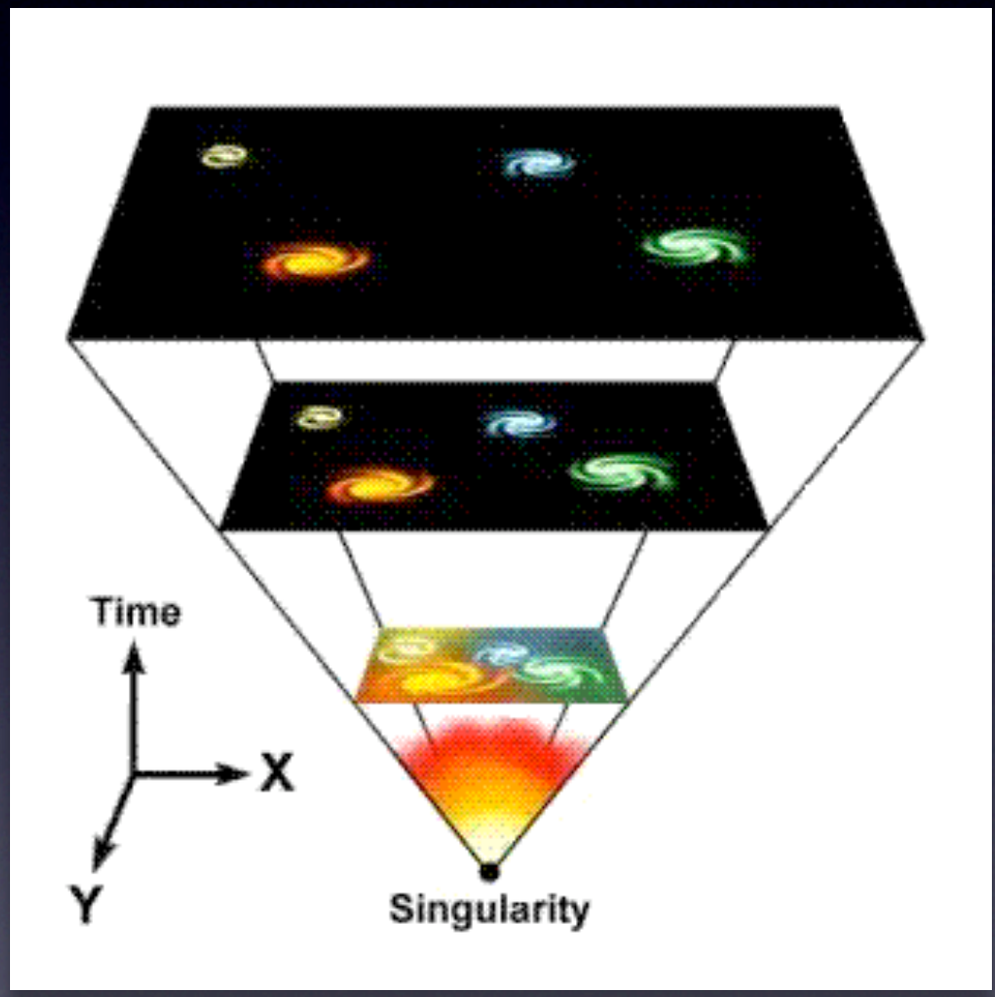
Si nous ne sommes pas au centre...





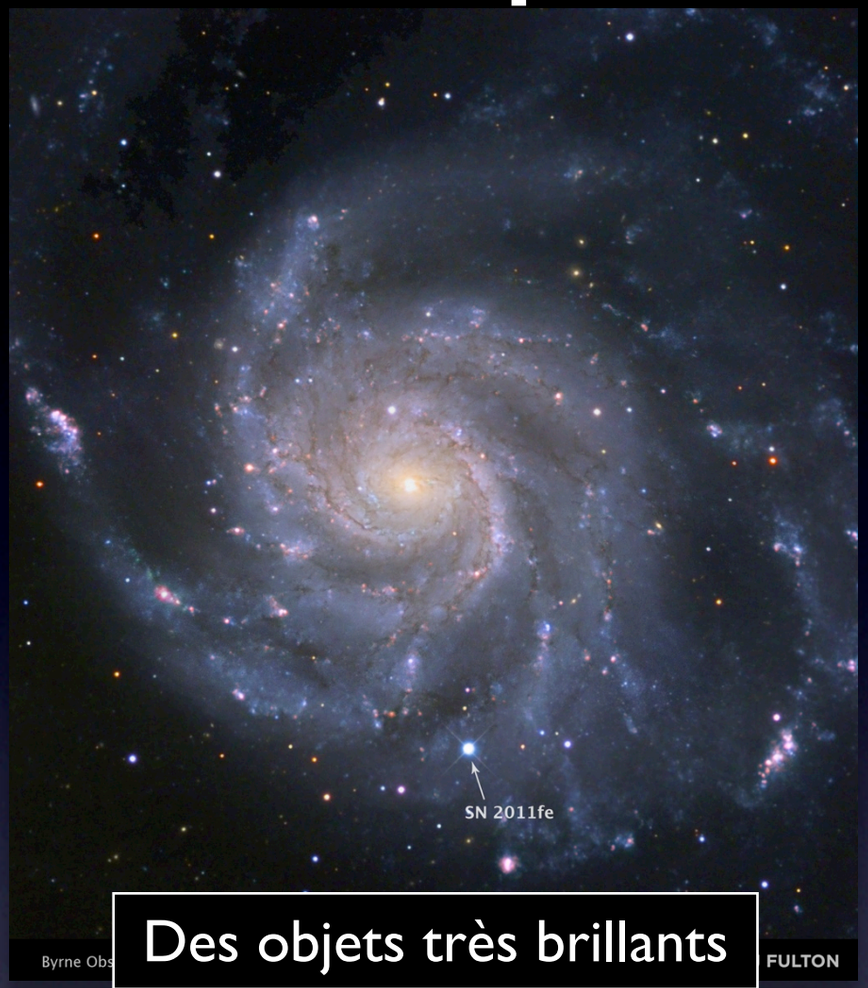






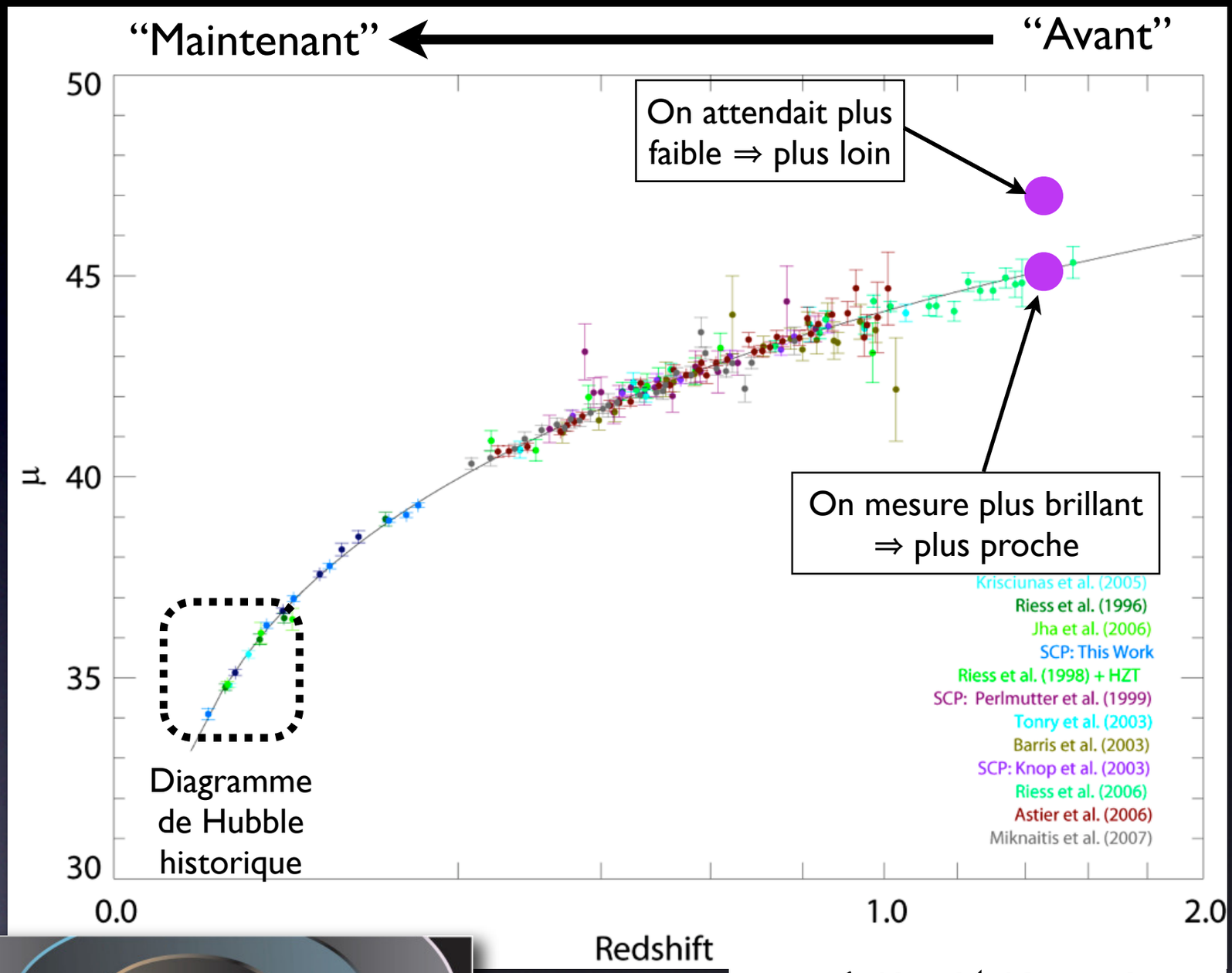
...Alors l'univers est en expansion !

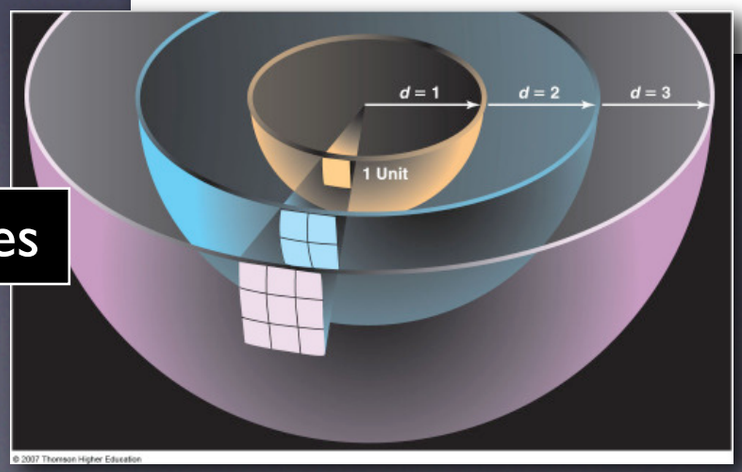
Des supernovae pour “voir” plus loin



Des objets très brillants

et très homogènes

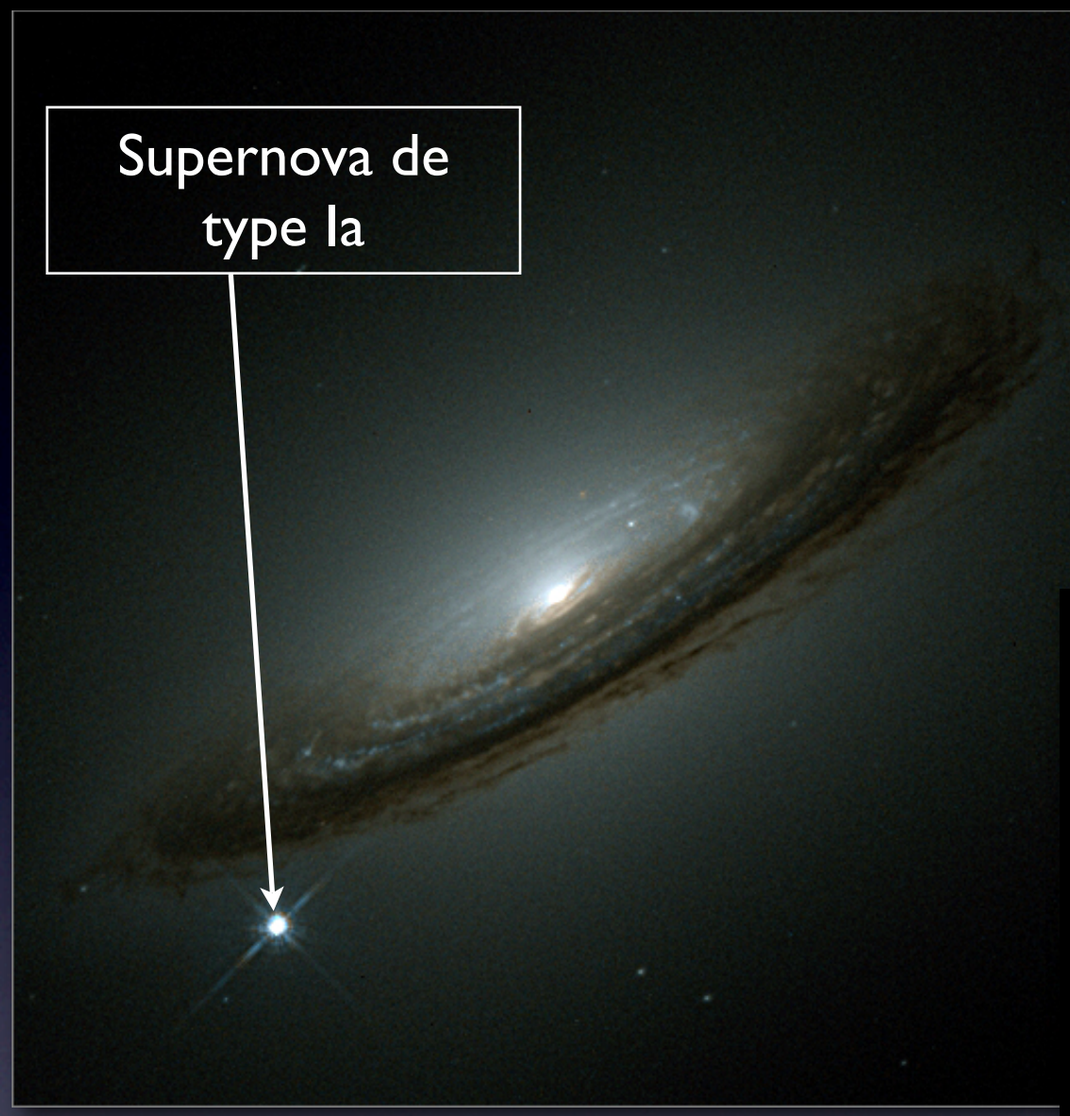




⇒montre que

l’Univers est en expansion accélérée

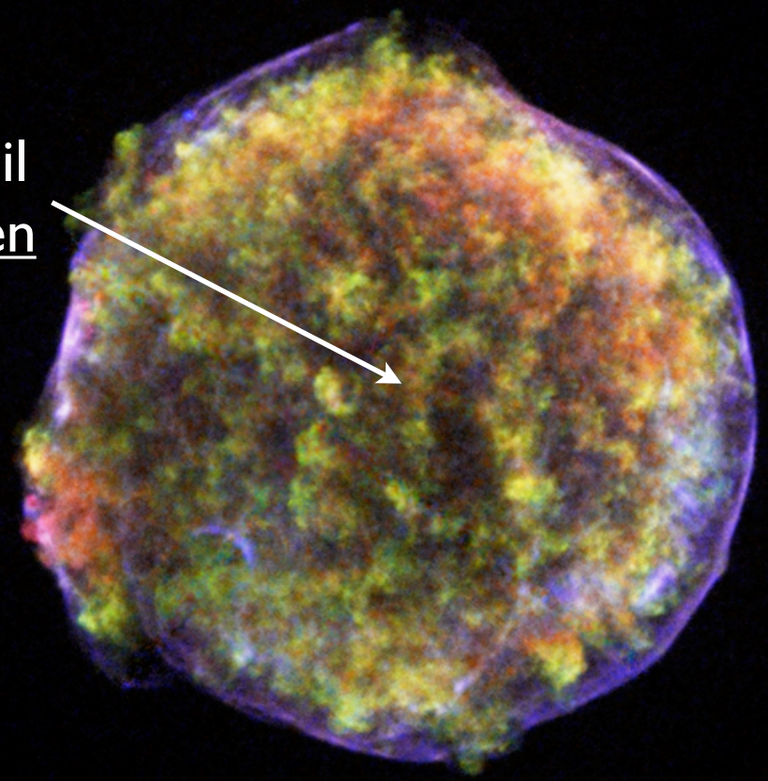
Des objets TRÈS brillants

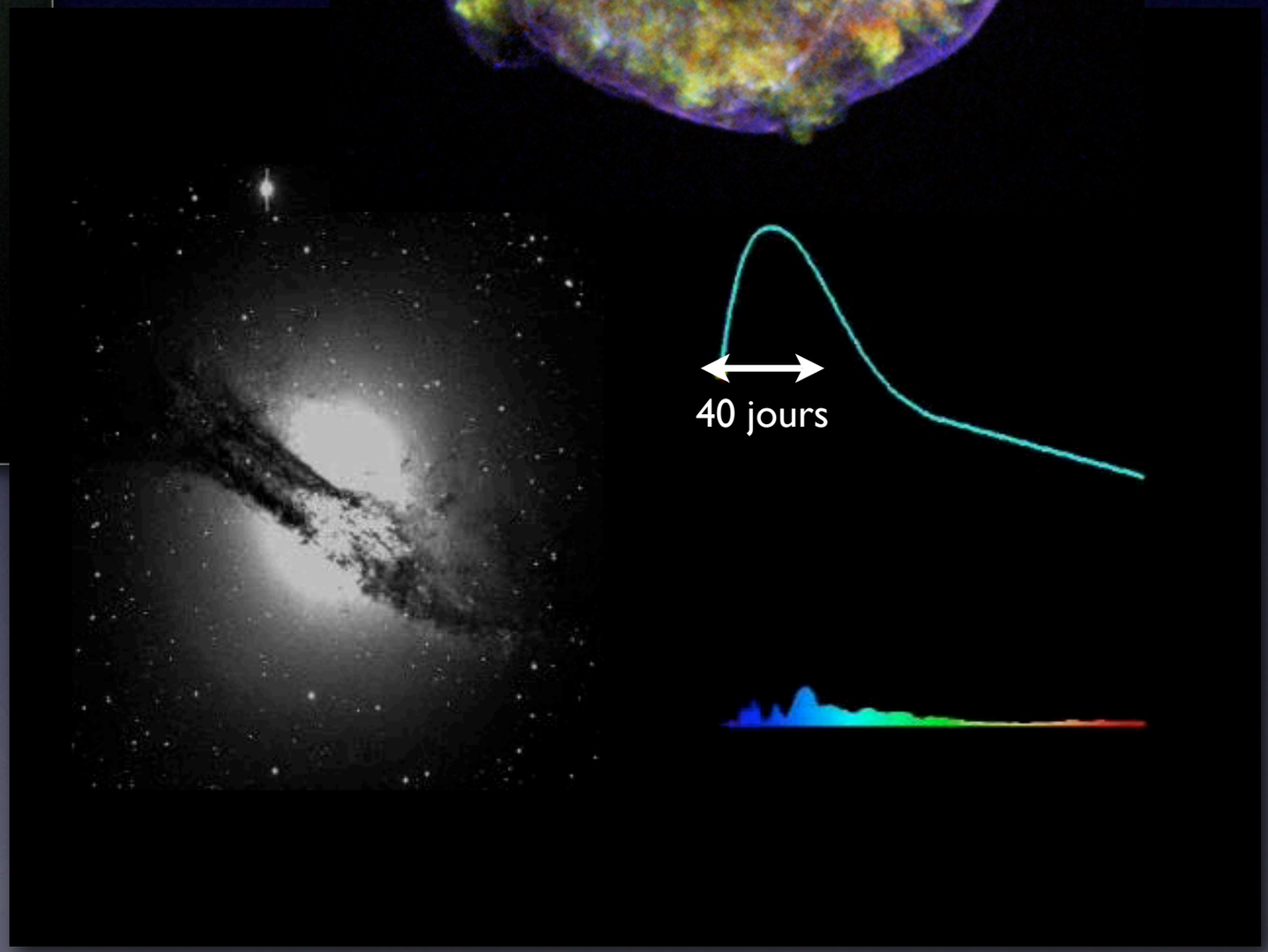


Explosion thermonucléaire d'une Naine Blanche

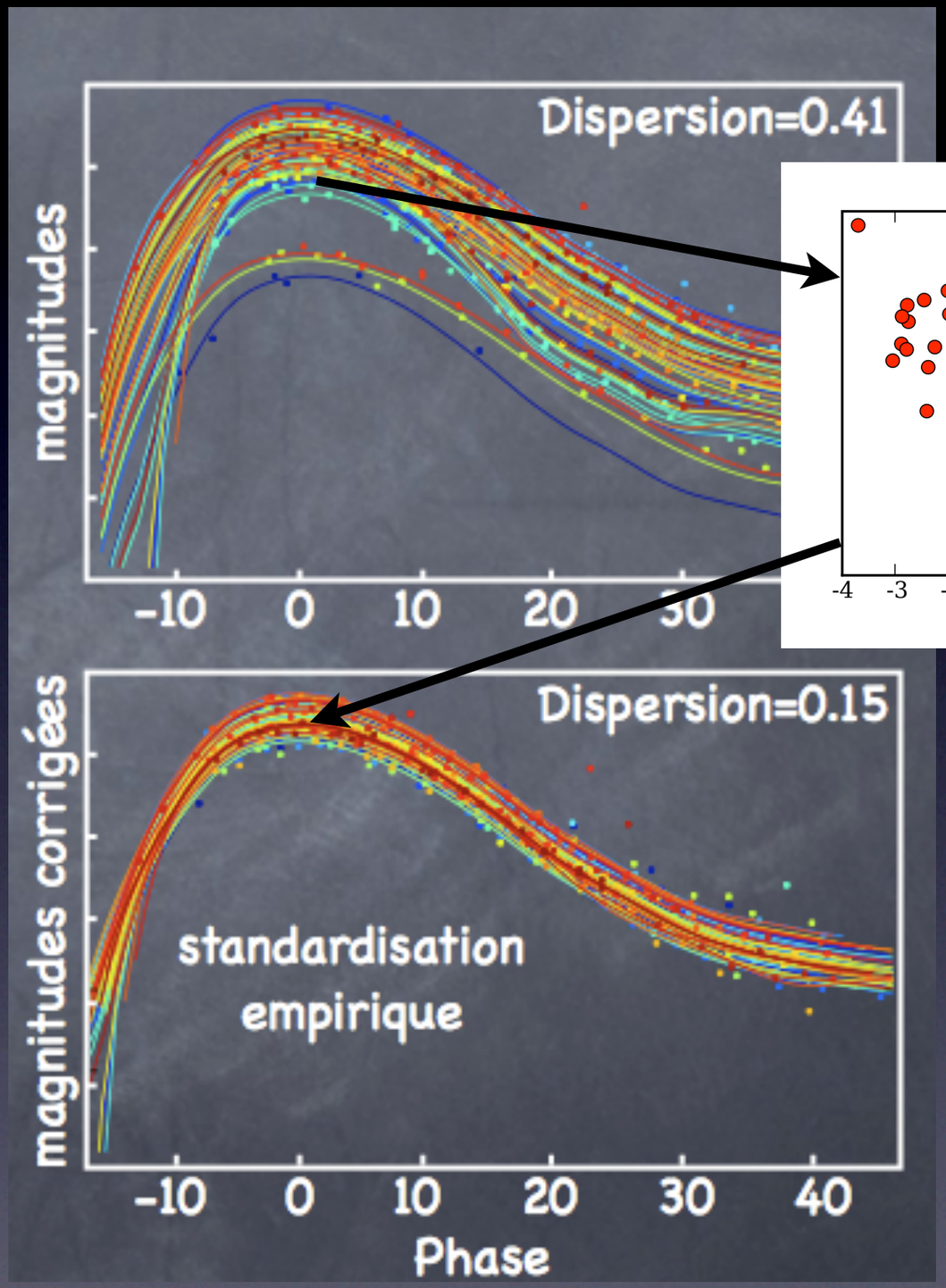
1.4 Masse solaire ⟷ Explosion ~ 15 secondes

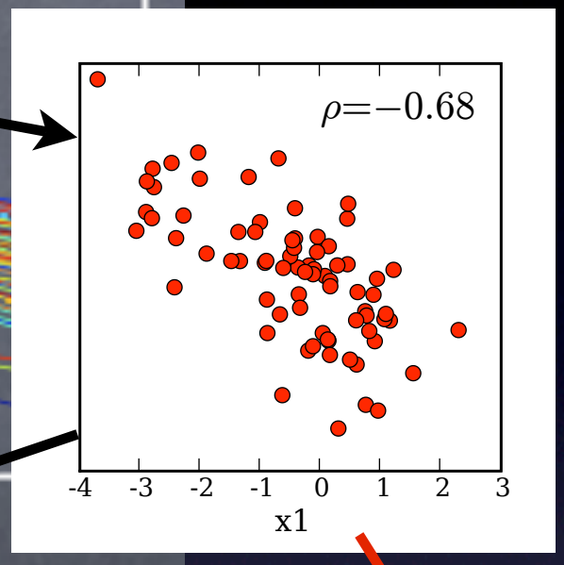
Au centre, il ne reste rien

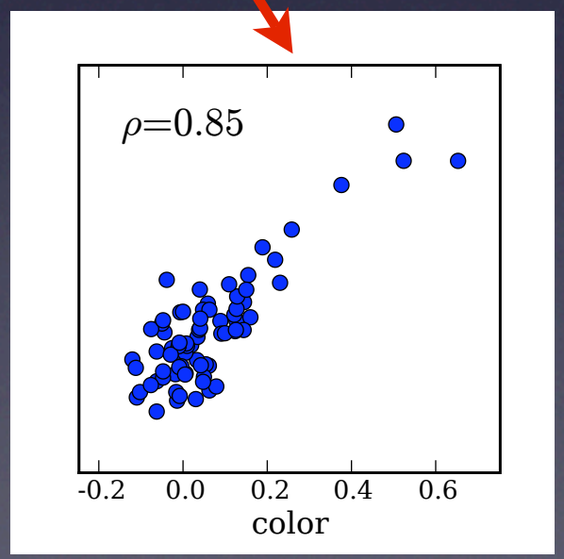


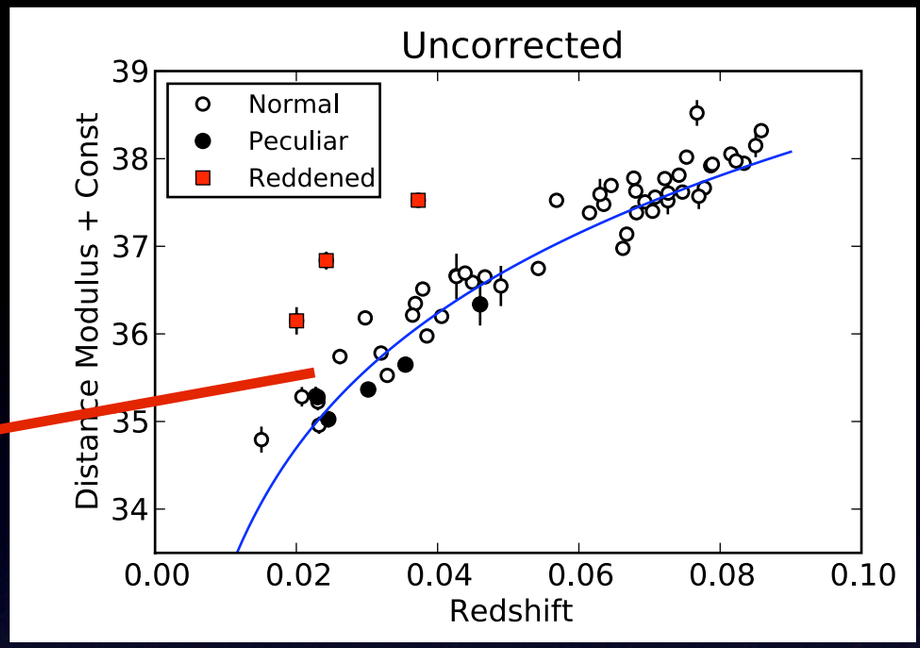


Des chandelles *standardisables*

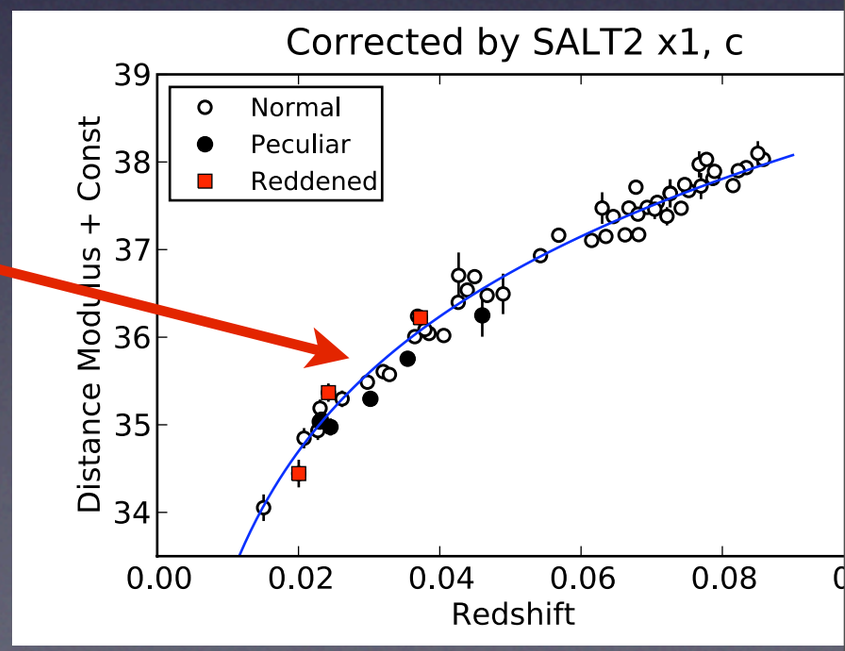






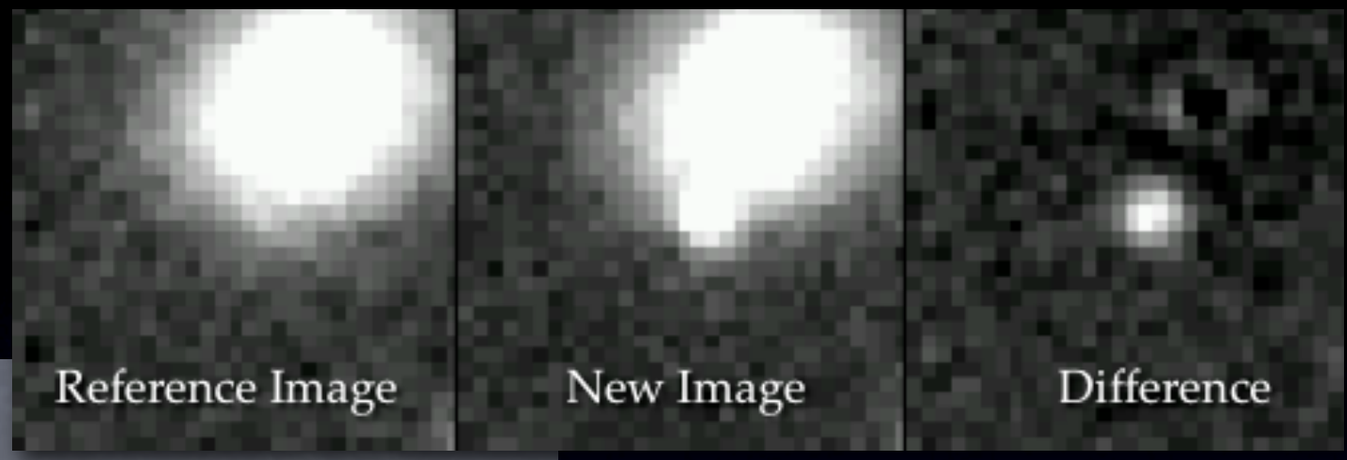


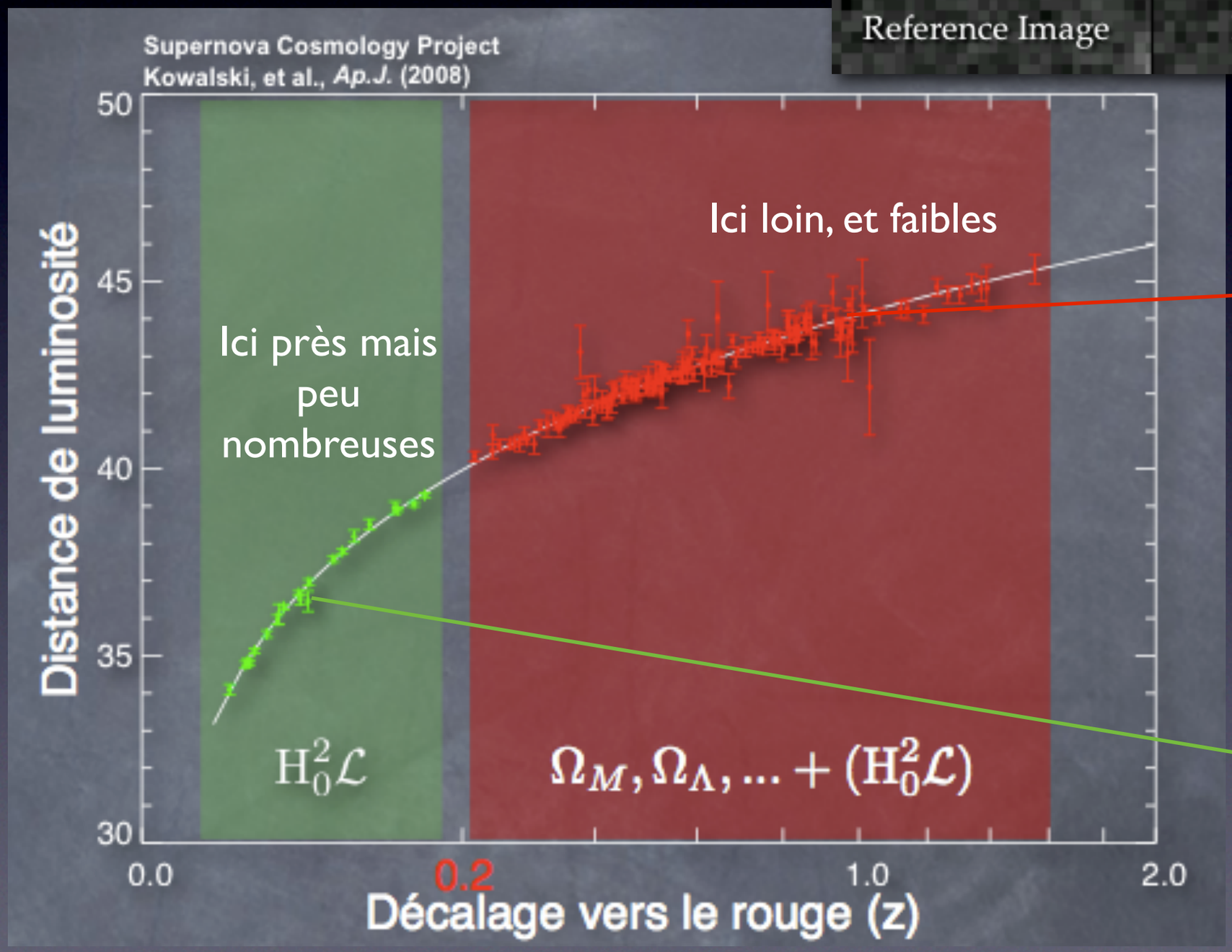
Diminution de la dispersion

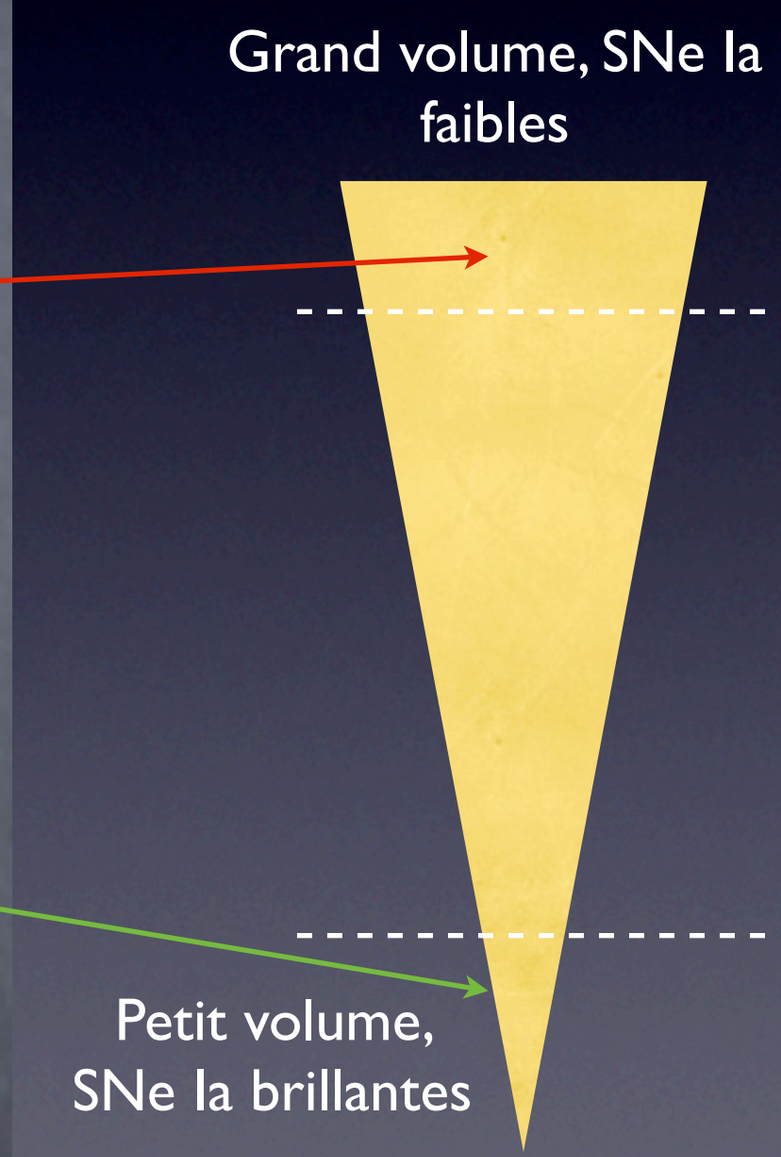


$$m_{obs} = M_0 + \mu_0 + \alpha\, x + \beta\, c + \mu$$

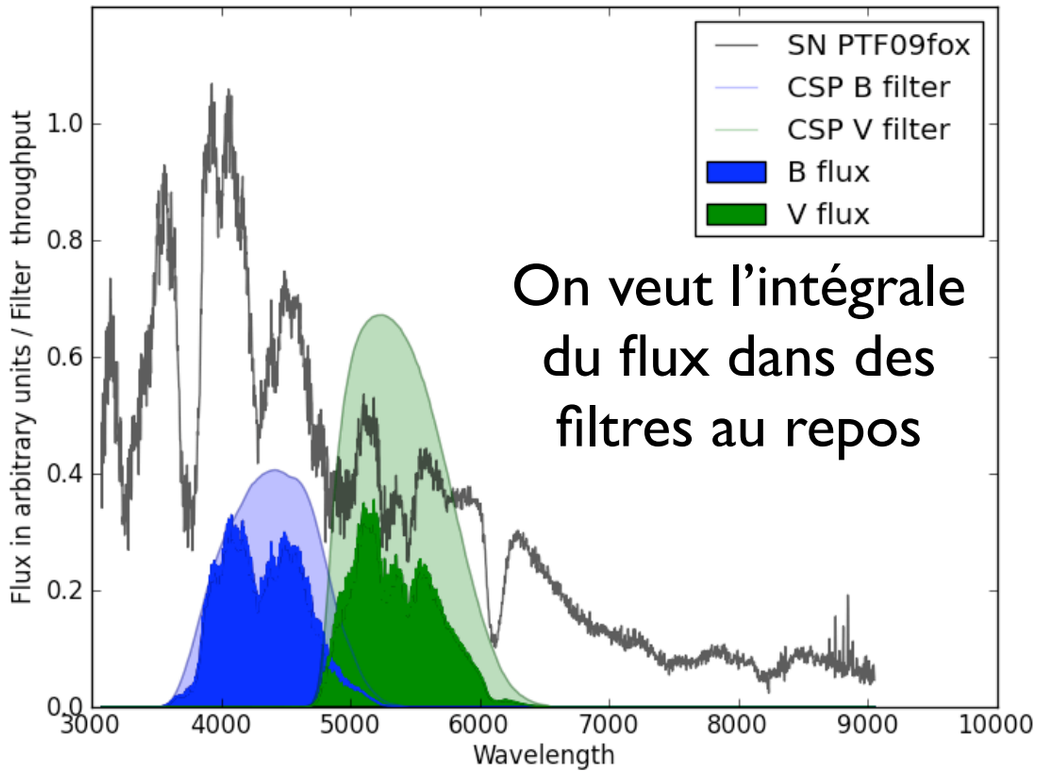
Pour mesurer les SNe Ia, il faut les trouver







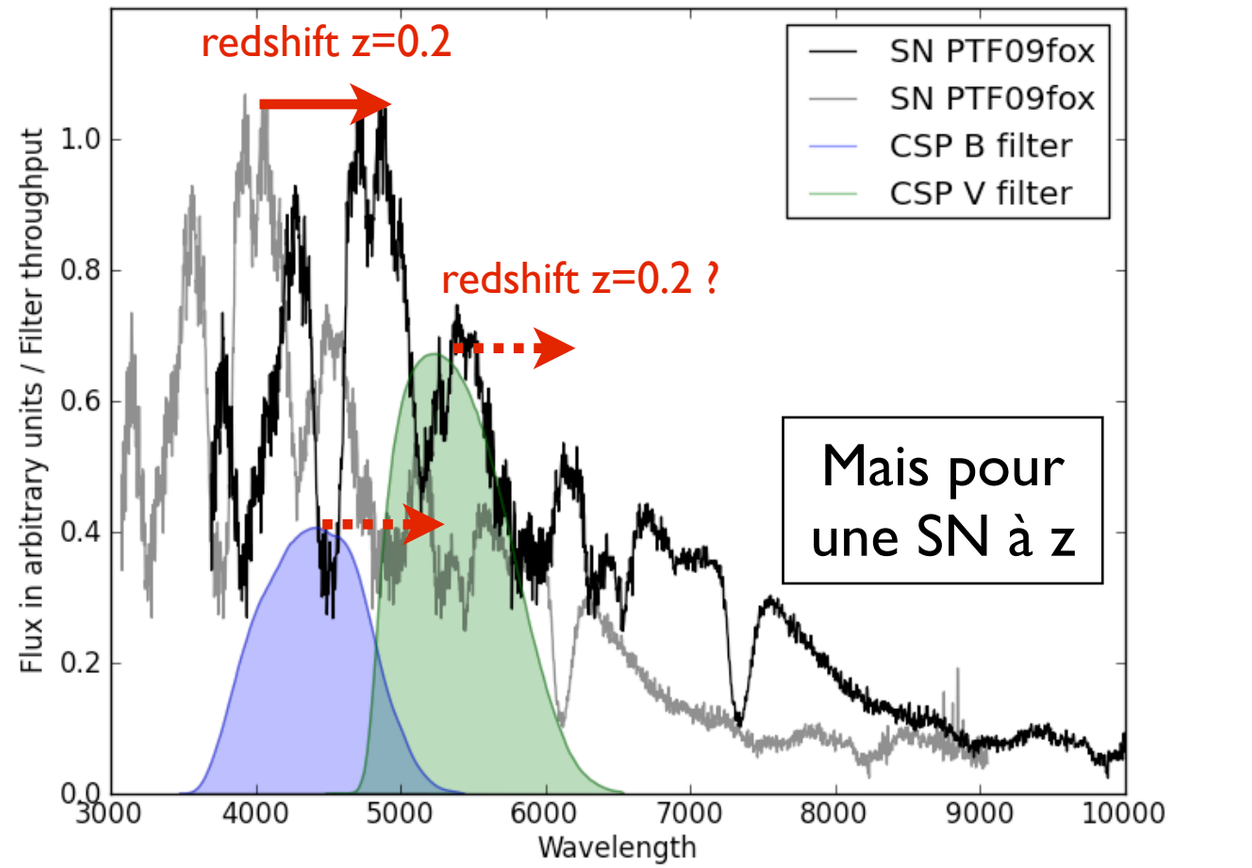
Quelques “petits détails” pratiques



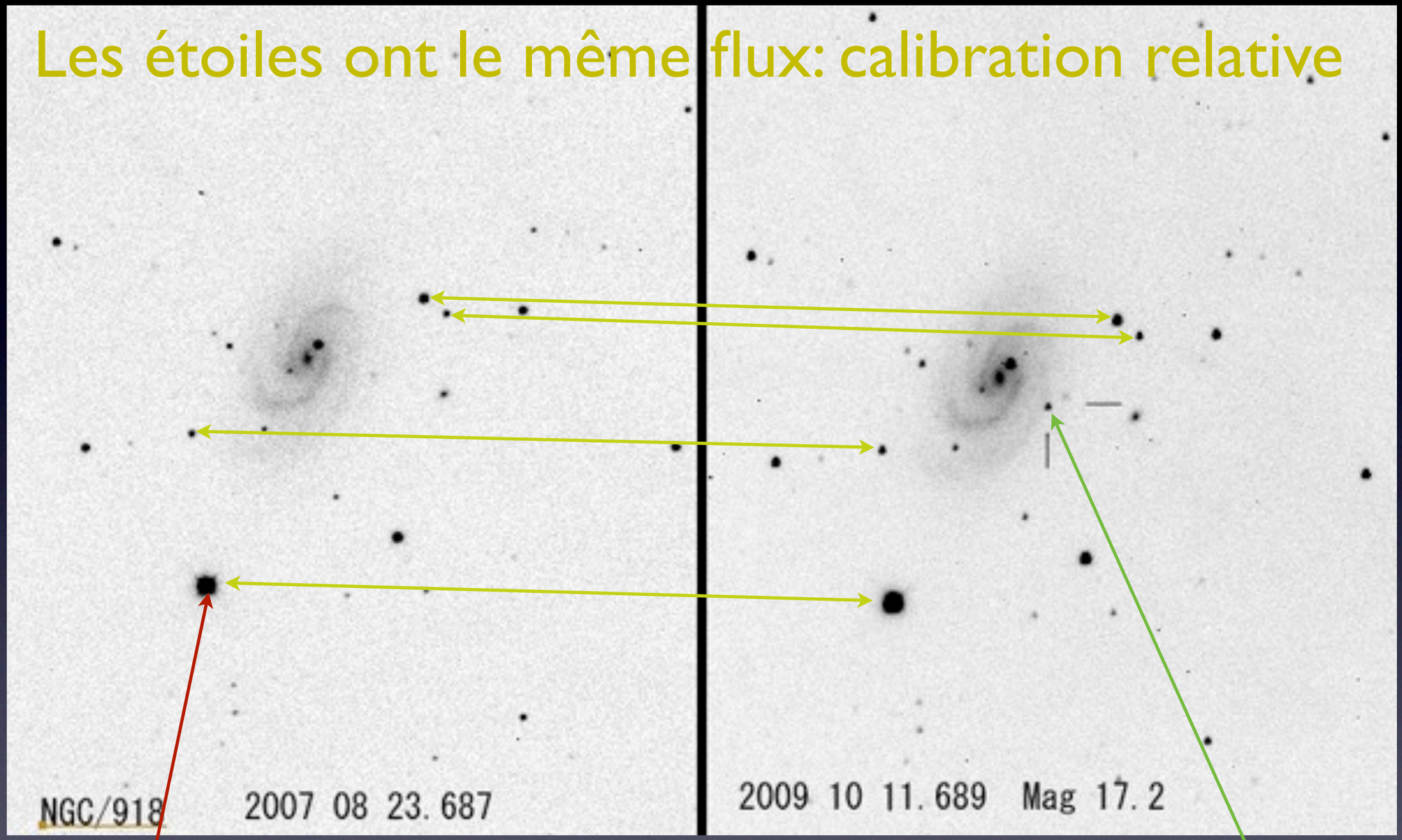
On doit trouver une correction pour chaque redshift ...

... Sans connaître le spectre de la SN

On fait la mesure dans les filtres au repos



Une calibration difficile



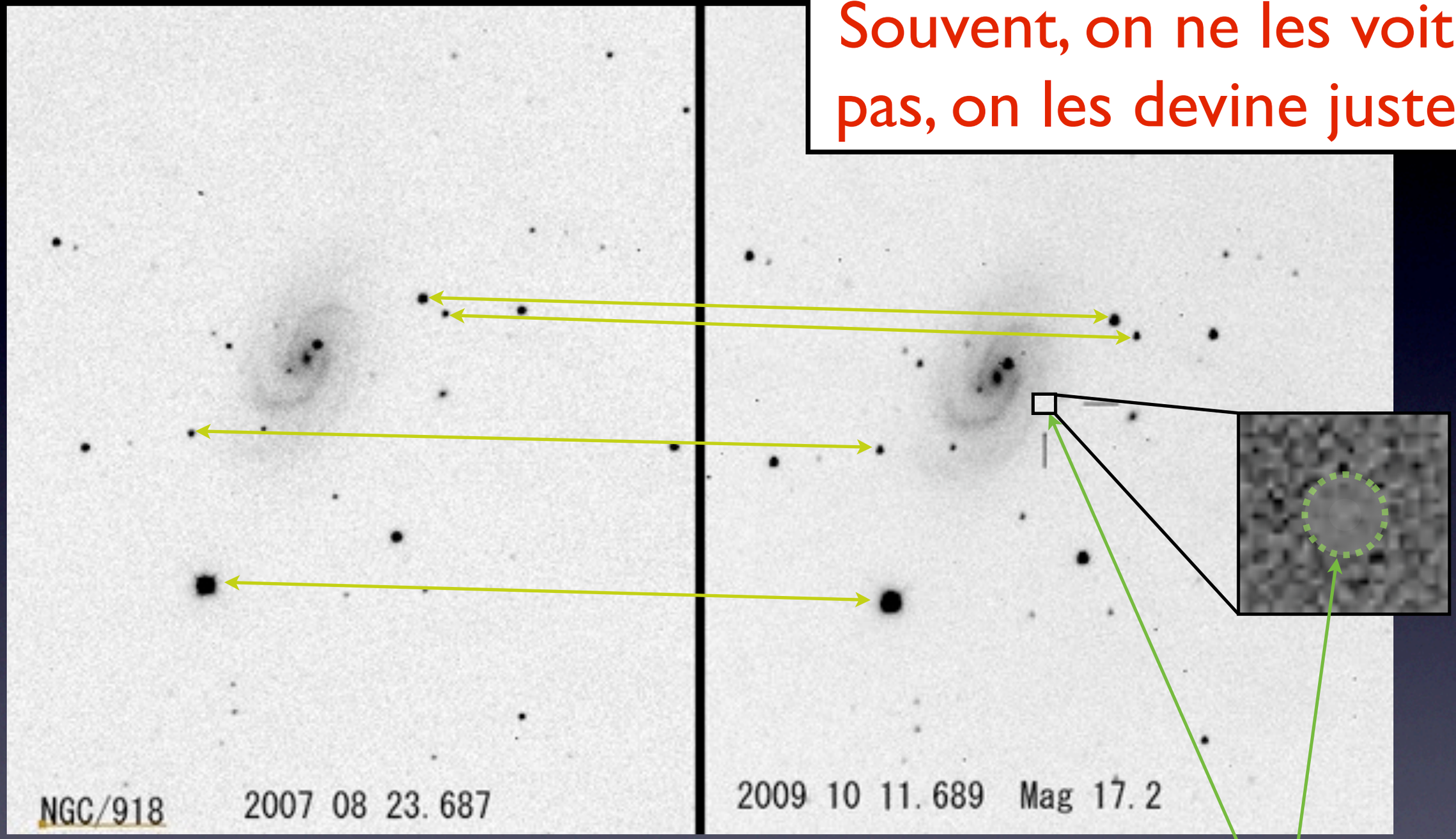
Étoile de référence

Calibration en flux

Supernova

Une calibration TRÈS difficile

Souvent, on ne les voit pas, on les devine juste



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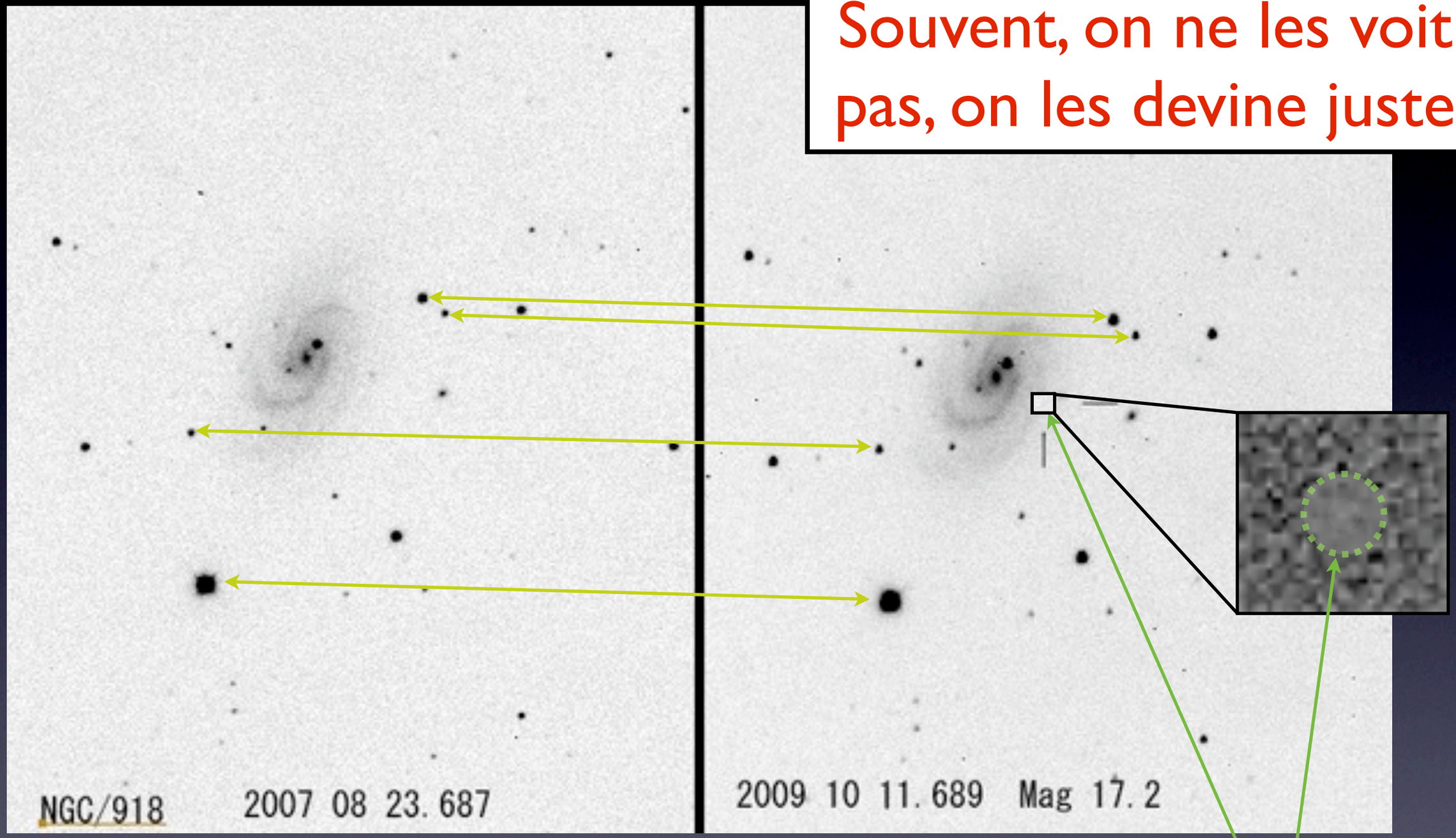


Fond de ciel variable + Bruit du détecteur + Supernovae très faibles

Couleur et extinction

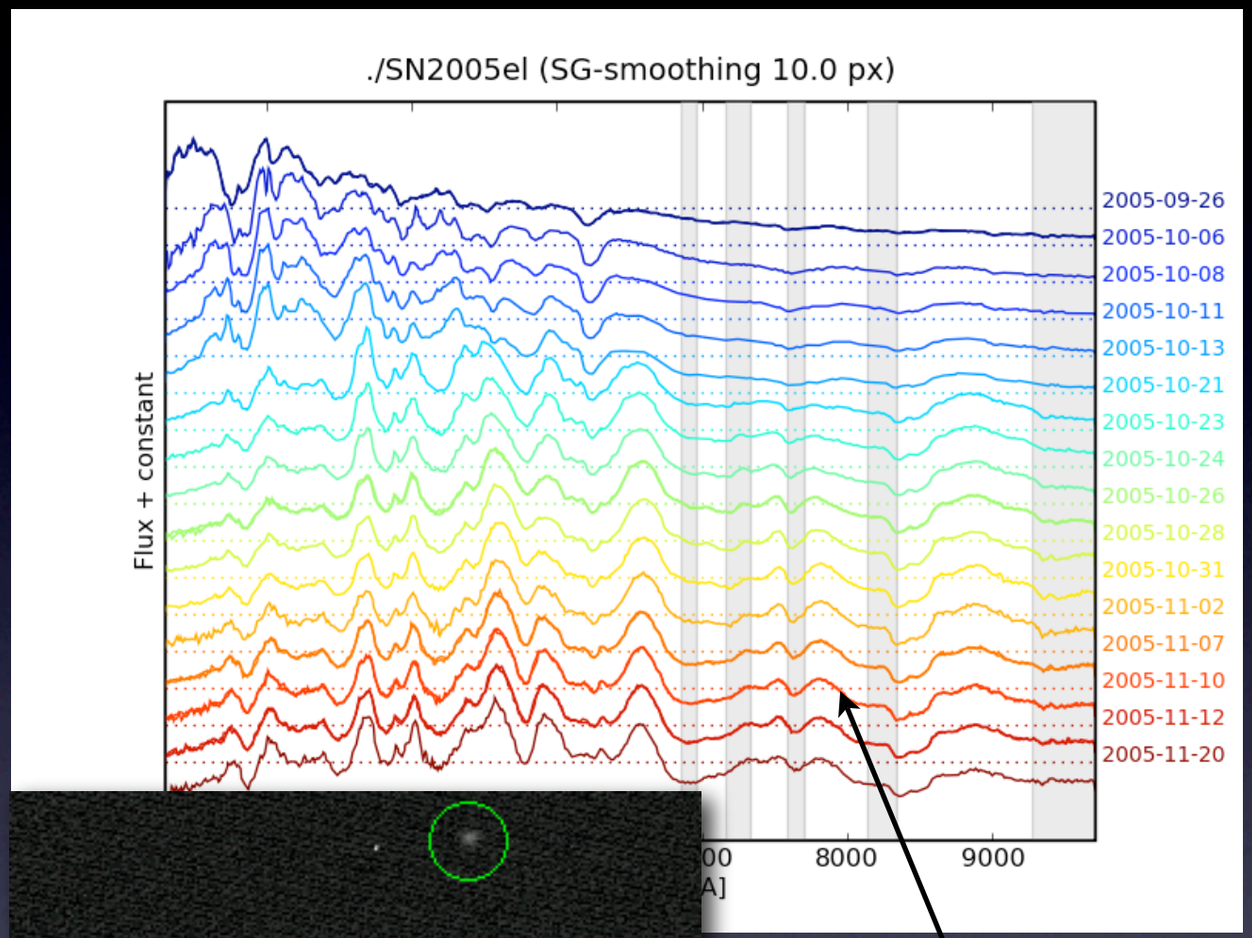
Si les poussières évoluent avec z ...

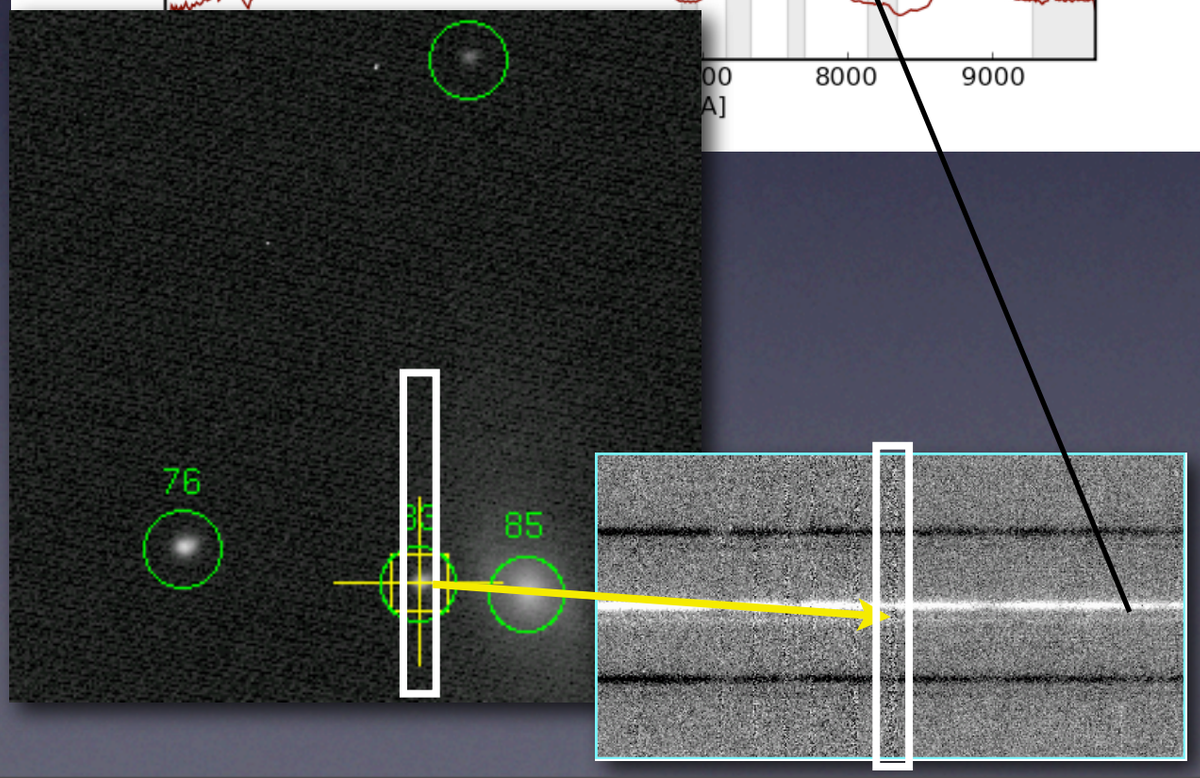
... On biaise la cosmologie

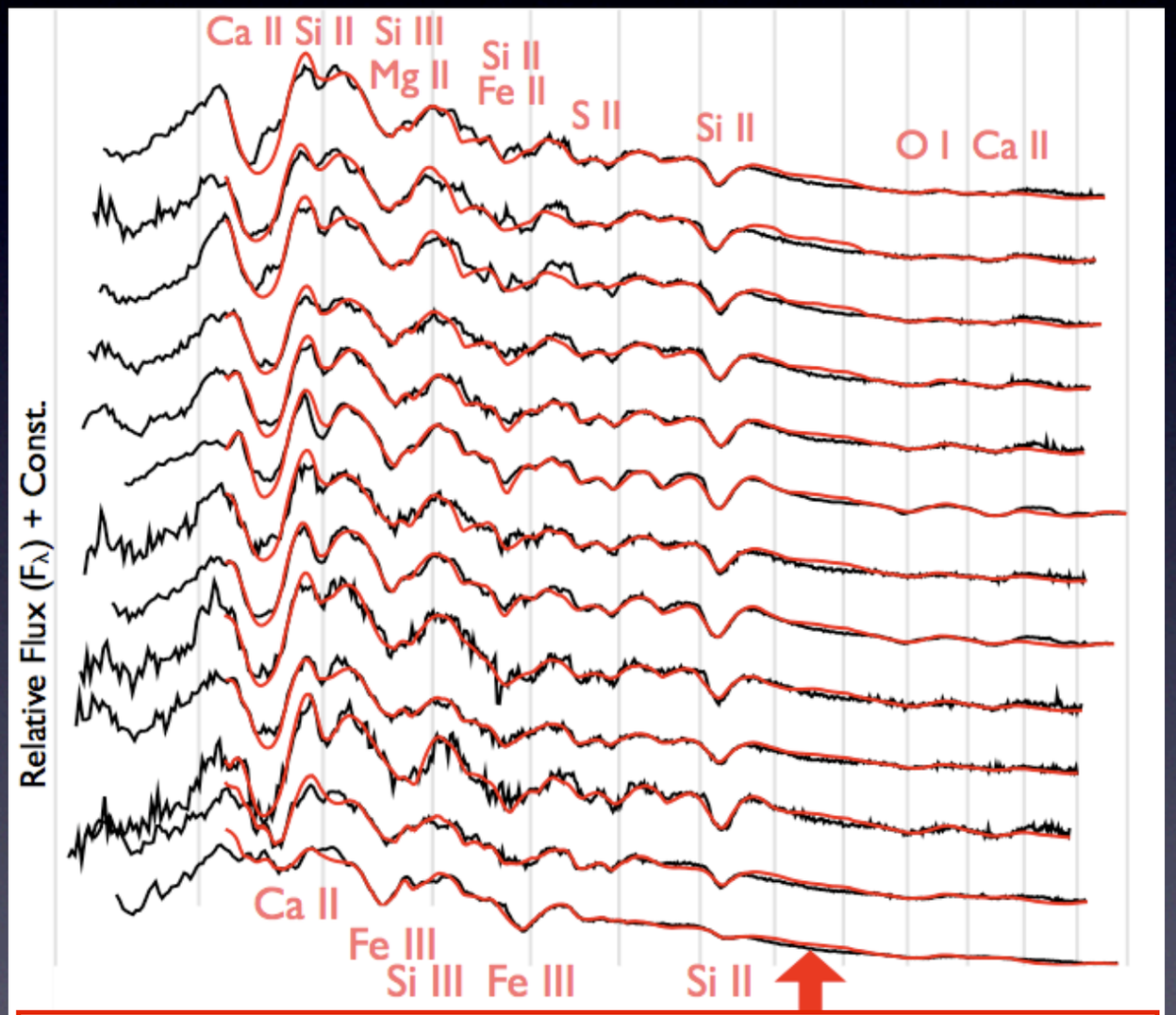
$$m_{obs} = M_0 + \mu_0 + \alpha\ x + \beta\ c + \mu$$

Et des SNe la dans la poussière

Des spectres pour comprendre les SNe Ia

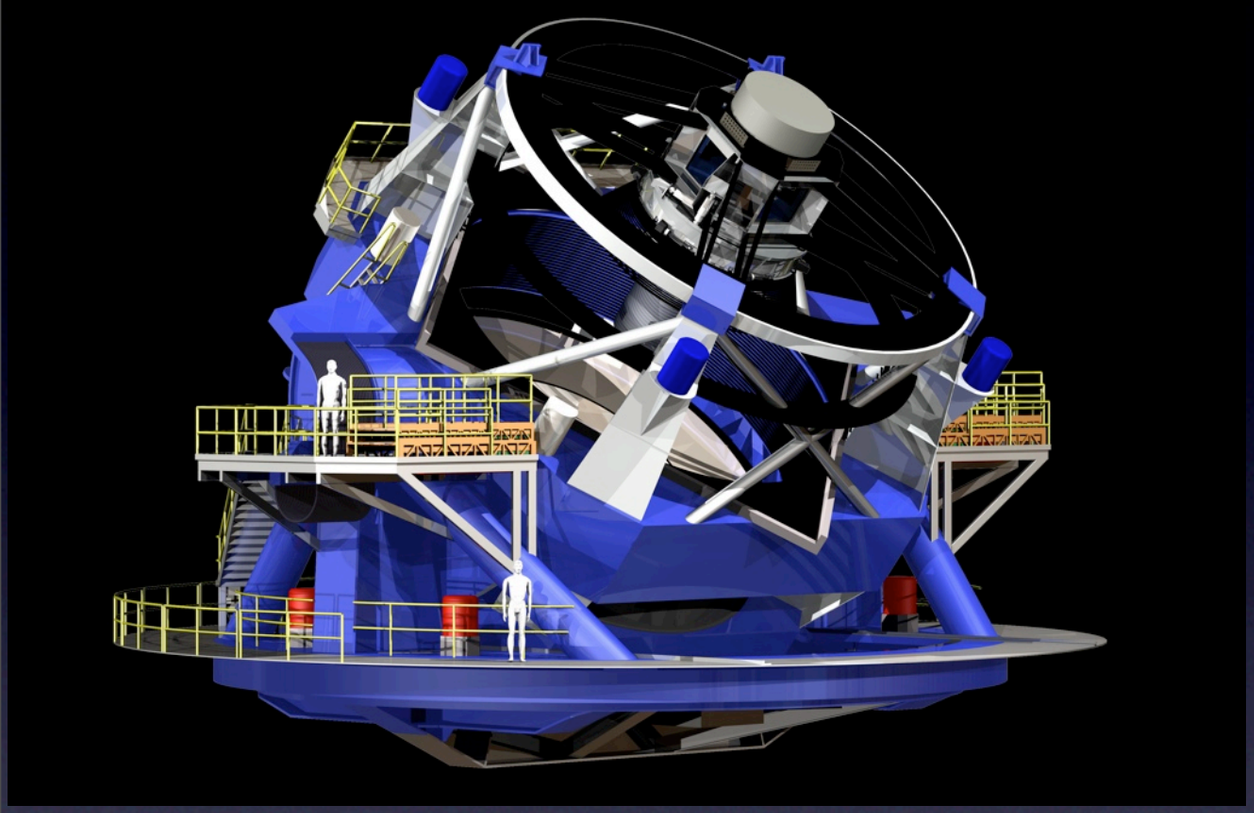


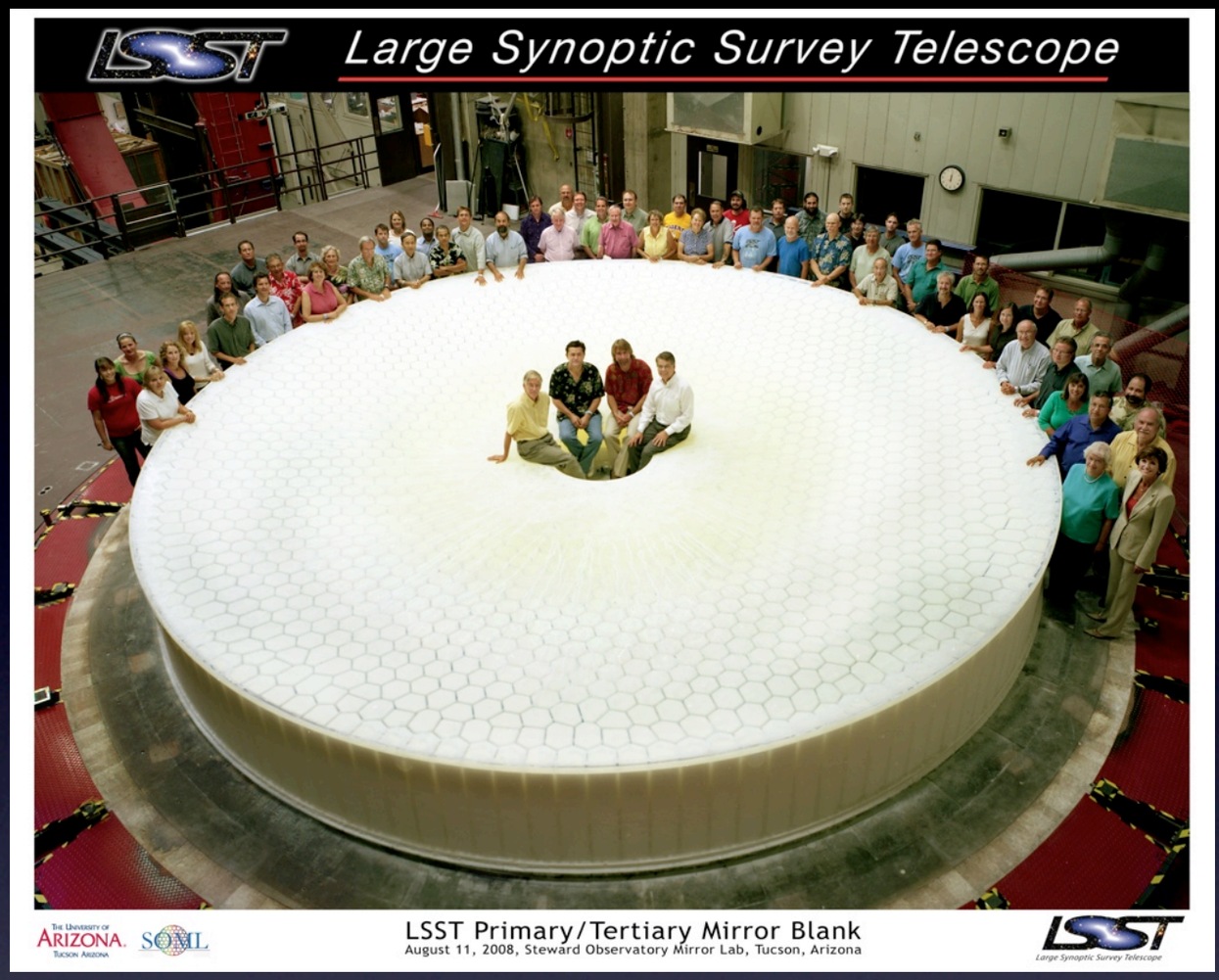




Comprendre la physique et les couleurs des SNe Ia

Et ensuite: vers l'infini...

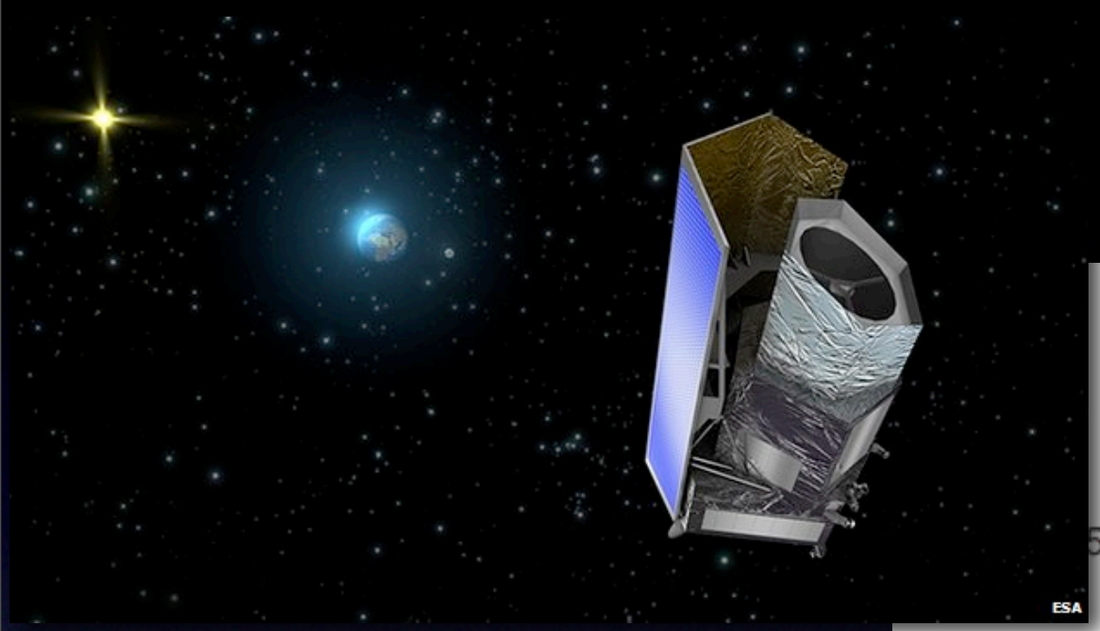




LSST pour trouver beaucoup de SNe Ia

\+ Bonne calibration instrumentale

… et au delà !



Euclid pour observer des SNe la très lointaines