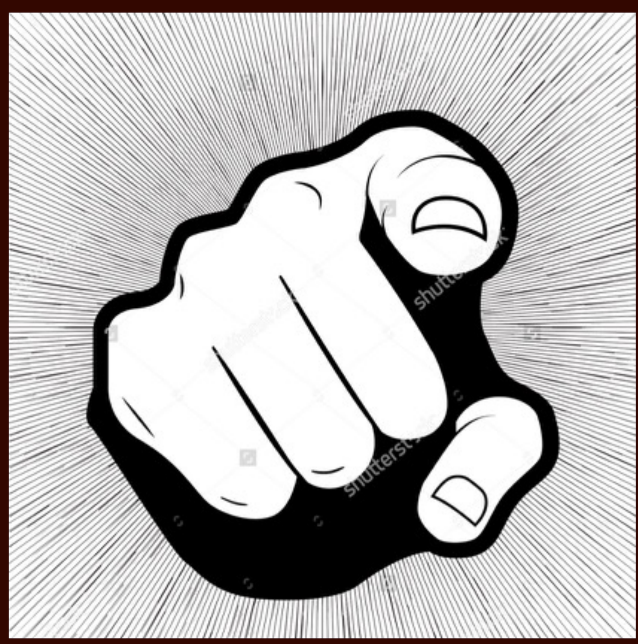

MegaMorph and it's capabilities in identifying key observable galaxy types [Or: “Why YOU should be using GalfitM!”]

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1) Why galaxy colour gradients are important!

The build-up of the red sequence galaxies from the star-forming galaxies in the 'blue cloud' is the key to understanding how those galaxies form. Several processes have been suggested for this transformation (see Fig.1). Major and minor mergers, SF quenching and in-situ star-formation can all move galaxies onto the red sequence and/or add mass to galaxies on the red sequence. Each of these processes leaves a **characteristic imprint** on the galaxy light and colour profiles.

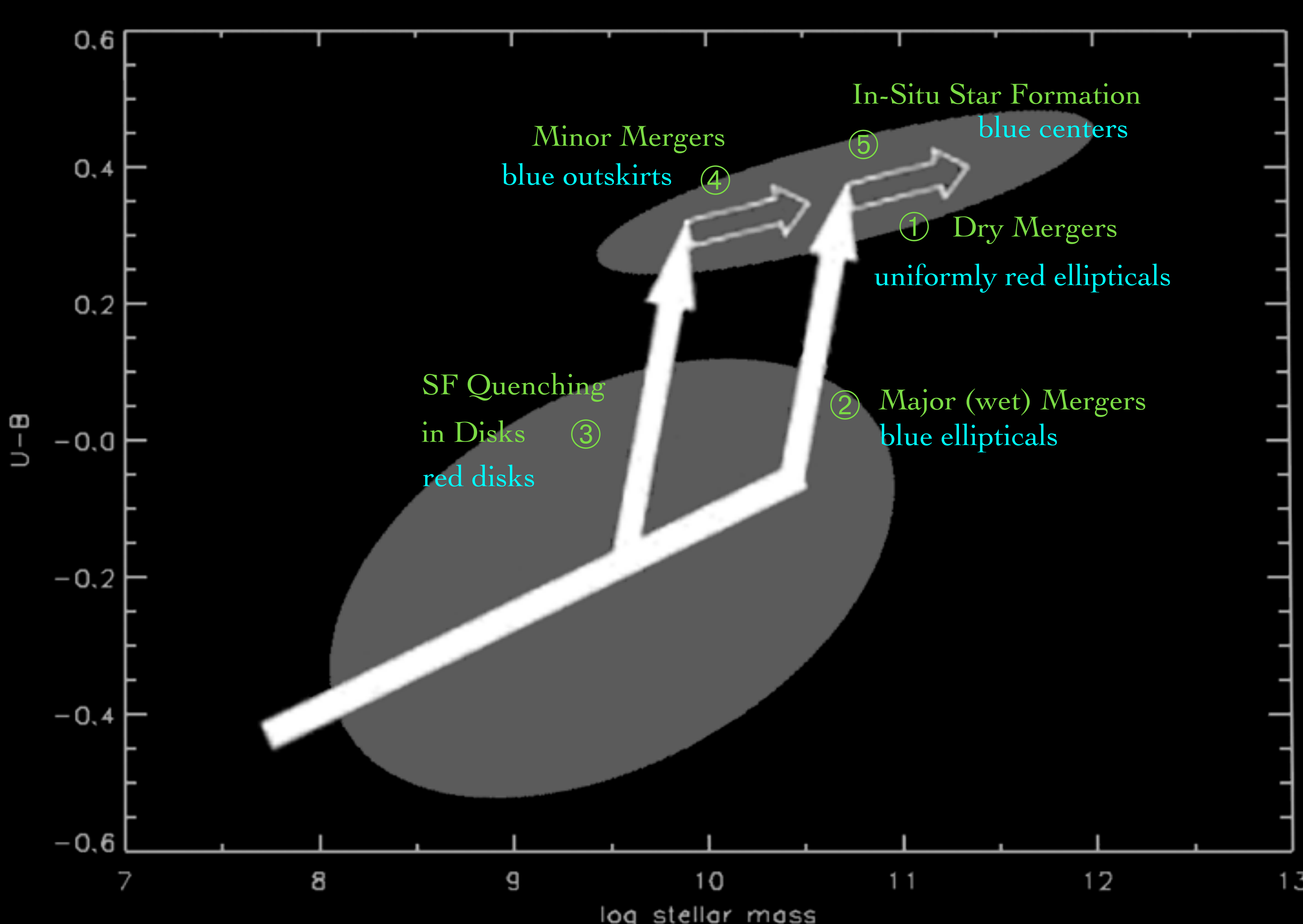

Fig. 1: Several processes can move/build mass on to the red sequence. Each of the processes leaves a characteristic finger print on the morphology, global colour and colour gradient of the resulting galaxy. These characteristics can be used to identify interesting galaxy samples and measure the relative strengths of the different processes.

2) Why GalfitM and Galapagos-2 can help!

In order to identify the relative importance of the different processes, both the identification of the respective samples and the accurate measurement of their properties are vital.

Within MegaMorph, we developed GalfitM - a multi-band version of the well known galaxy light profile fitting code Galfit - which has a major advantage in that it can measure galaxy parameters using several images at different wavelengths (or even IFU data, see poster by E. Johnston) simultaneously and in a consistent manner. Instead of simple galaxy parameters of the light profiles (e.g. in the Sérsic profile), it fits polynomials (as a fcn of wavelength), which allows/forces a smooth variation of parameters with wavelength. This allows the code to effectively interpolate e.g. over noisy images (see Fig 2).

This has several advantages:

- all data is used, effectively increasing signal-to-noise
- smooth parameter variation is guaranteed
- interpolation of restframe values is possible
- measurements of e.g. colour gradients are a natural result of this method.

Over all, this method leads to more secure measurements of galaxy properties - and hence a more secure identification of galaxy populations.

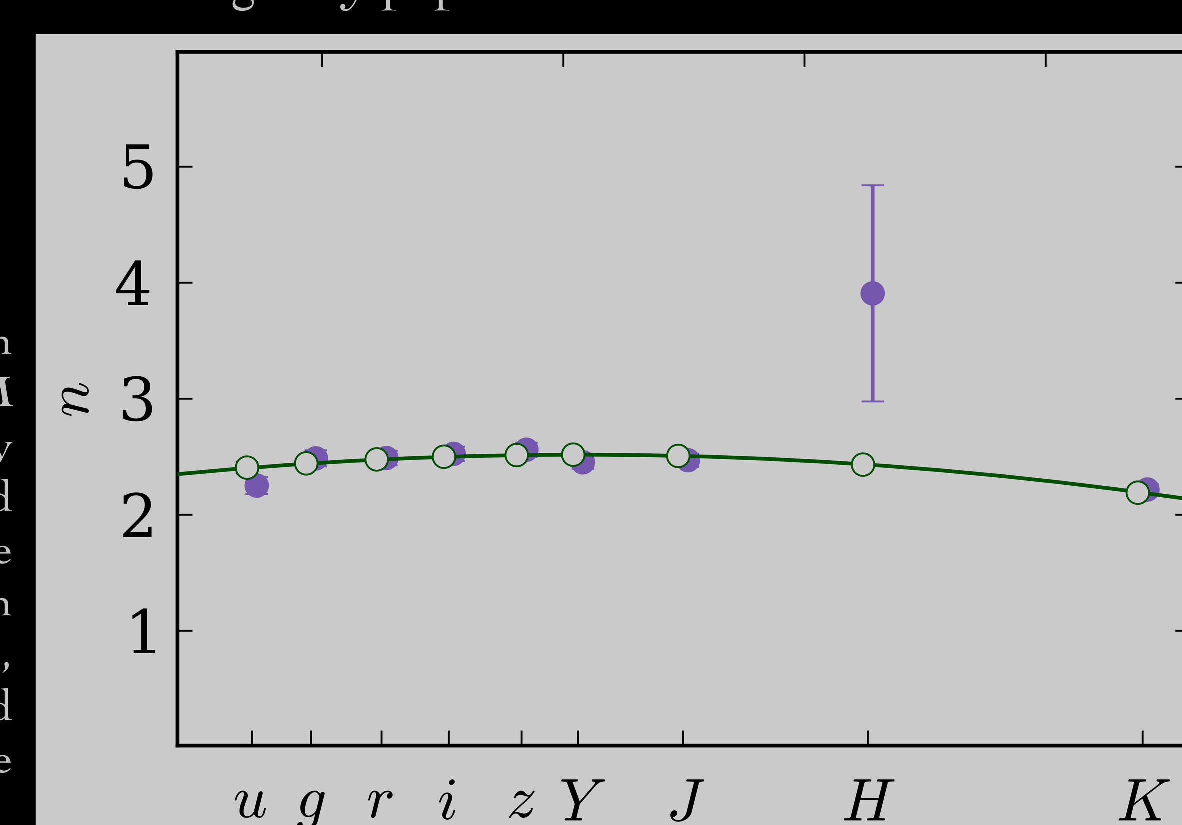

Fig. 2: This simulation illustrates how GalfitM simply interpolates over noisy images (here the H-band) and derives much more accurate galaxy parameters. Open circles show simulated values, purple circles the single-band fits, the green line shows the multi-band fitting result.

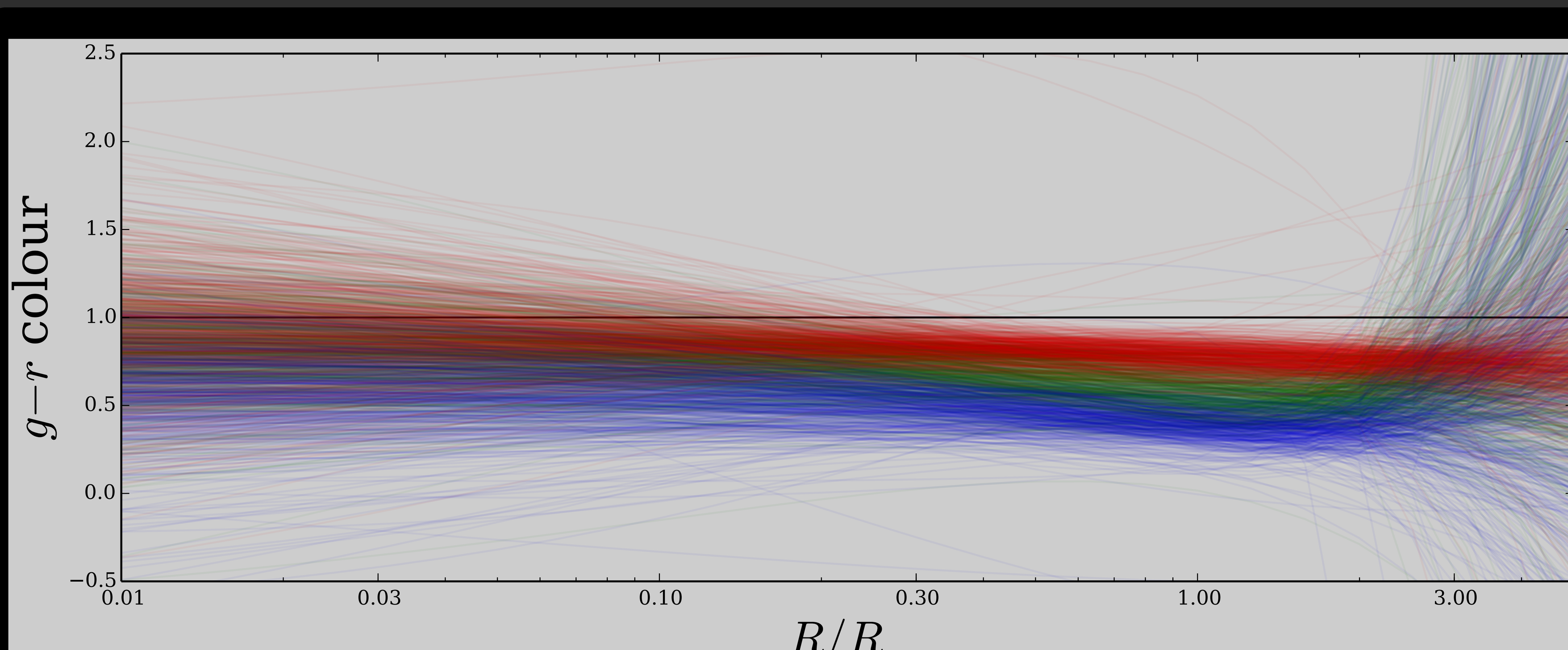

Fig. 3: This figure illustrates g-r colours derived/calculated from the light profile fits with GalfitM. Colour coding shows the over all colour of the galaxy as red to blue. The outermost parts of the colour profiles will be dominated by the uncertainty in the sky measurement and should be taken with a big grain of salt.

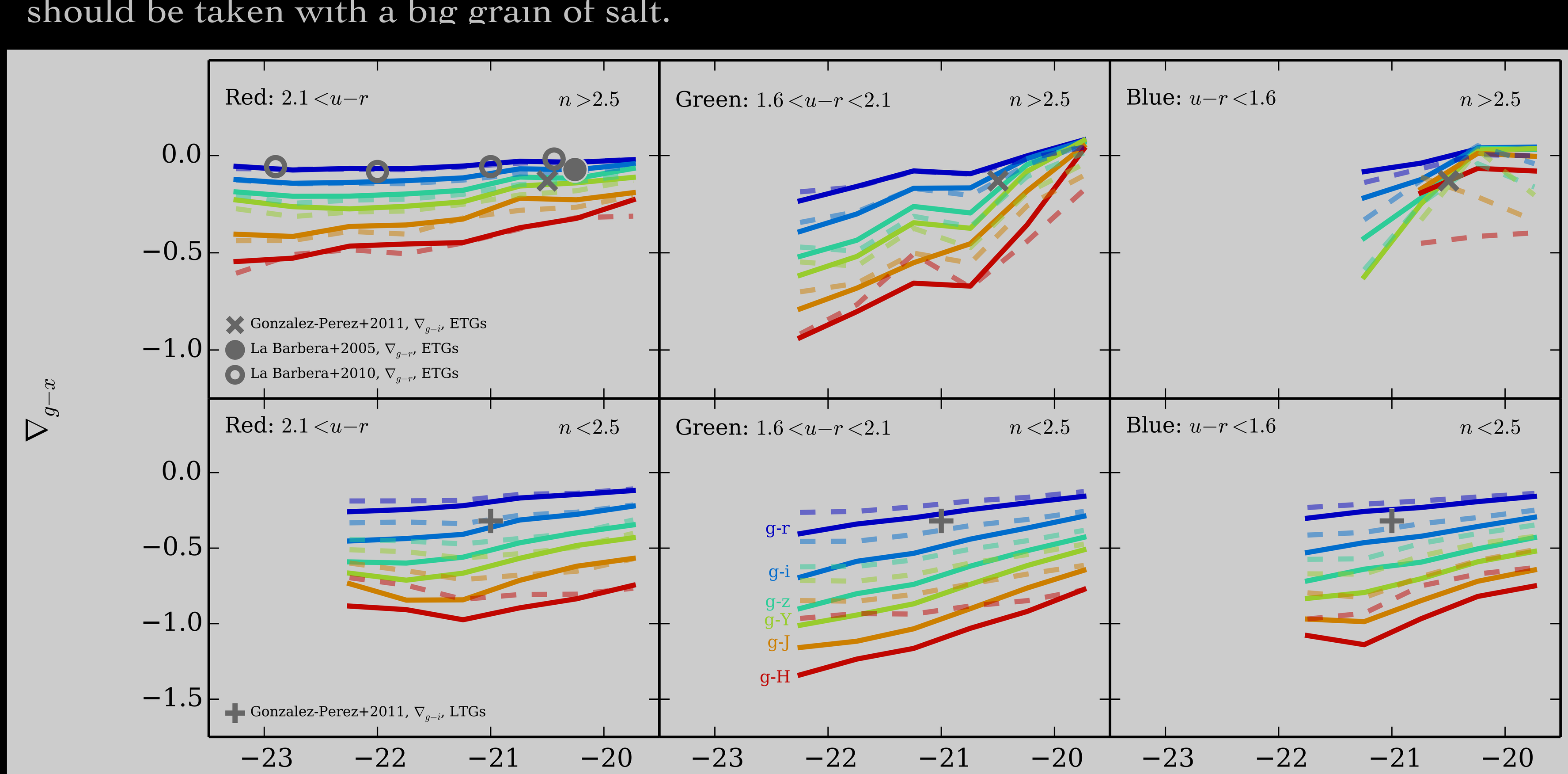

Fig. 4: The colour gradients measured this way agree well with other works, but can be computed automatically for a much larger sample of galaxies. Solid/Dashed lines show gradients for $0.1r_e$-$1r_e$ and $0.1r_e$ to $2r_e$, respectively, normalized by difference in radius.

Results: Measuring Galaxy Colour Gradients

Using a sample of galaxies from the GAMA survey, we have shown that we can compute colours and colour gradients simply from the fitting parameters from GalfitM, instead of measuring them on a noisy 2D image (Kennedy et al., 2016, A&A research note, re-submitted). In theory, this delivers more accurate and less noisy colour gradients and can be carried out using a GalfitM wrapper like Galapagos-2.

Fig. 3 shows the individual colour gradients of all galaxies in our sample, colour coded by their overall colour (red: red, blue: very blue). By design, these colour gradients are smooth and can be used to calculate the galaxies colour at any radius.

Fig. 4 shows the colour gradients calculated this way as a function of galaxy type (colour and high/low-sérsic index) and luminosity. As expected gradients between more distant filters are always stronger. We can see that colour gradients in high-n galaxies do not change when measured over a larger r_e-range, e.g. colour gradients are consistently steep at all radii, consistent with La Barbera & Carvalho, 2009), with fainter galaxies showing weaker gradients (den Brok, 2011). Low-n galaxies show flatter gradients when measured over larger r_e-range, consistent with the presence of a bulge within a homogeneous outer disk. the trend shows that this bulge is brighter in brighter galaxies.

Comparison with other studies shows that the colour gradients measured using GalfitM are consistent with previous measurements. Due to the technique, they can now be measured automatically on large samples of 1000s of galaxies, rather than individually on bright nearby galaxies, improving statistical significance of the results and enabling measurement at more distant galaxies and examining environmental effects, where statistics are vital.

Code available under http://nottingham.ac.uk/astronomy/megamorph/

In case of question, please find me and ask!