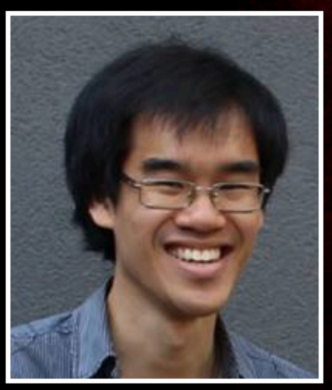

The magnetic field geometry of cool stars

Victor See[1], M. Jardine[1], A. A. Vidotto[2], J.-F. Donati[3], C. P. Folsom[4] et al.

[1]University of St Andrews, [2]Trinity College Dublin, [3]University of Toulouse, [4]University of Grenoble

wcvs@st-andrews.ac.uk

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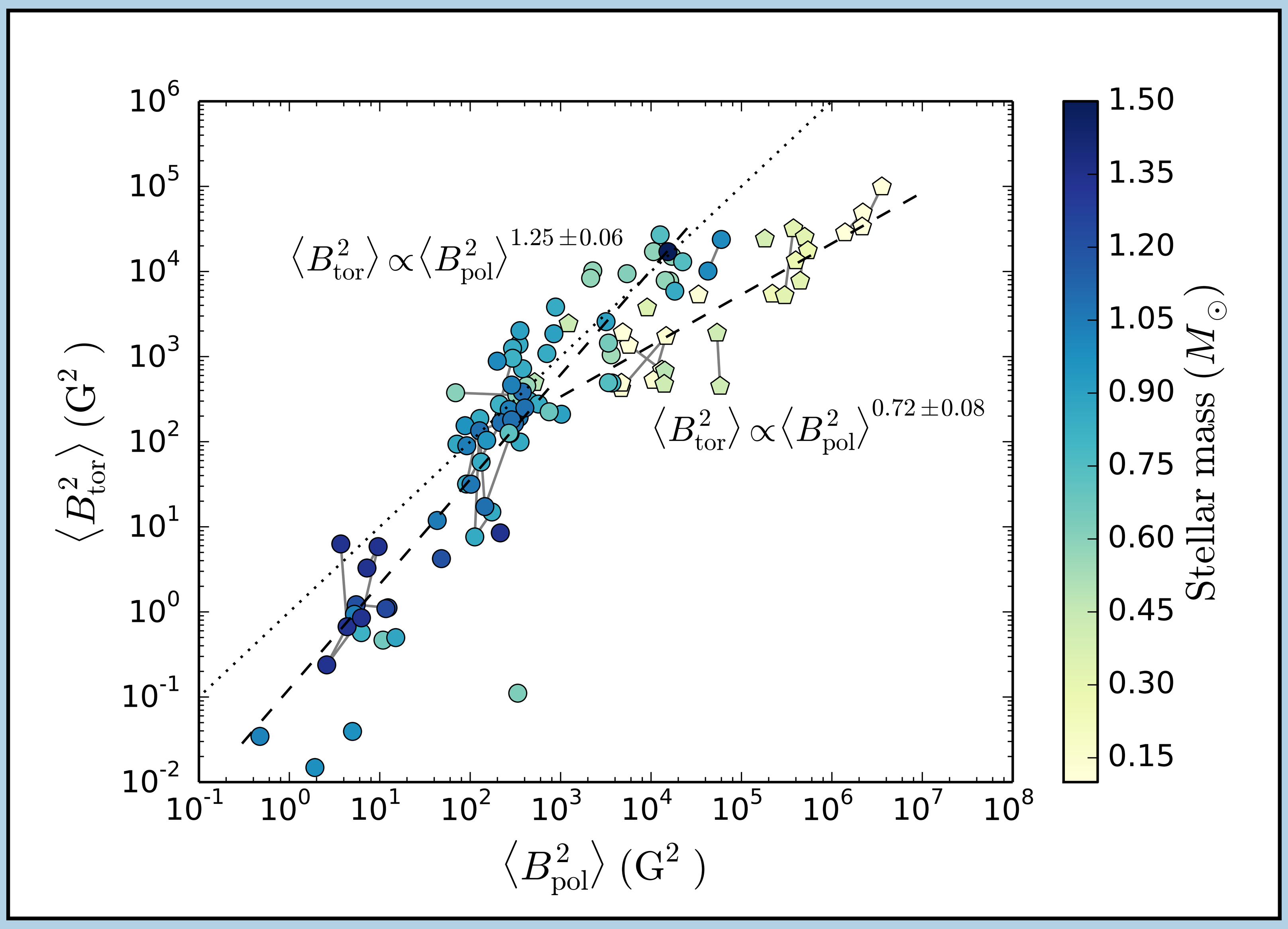
Introduction

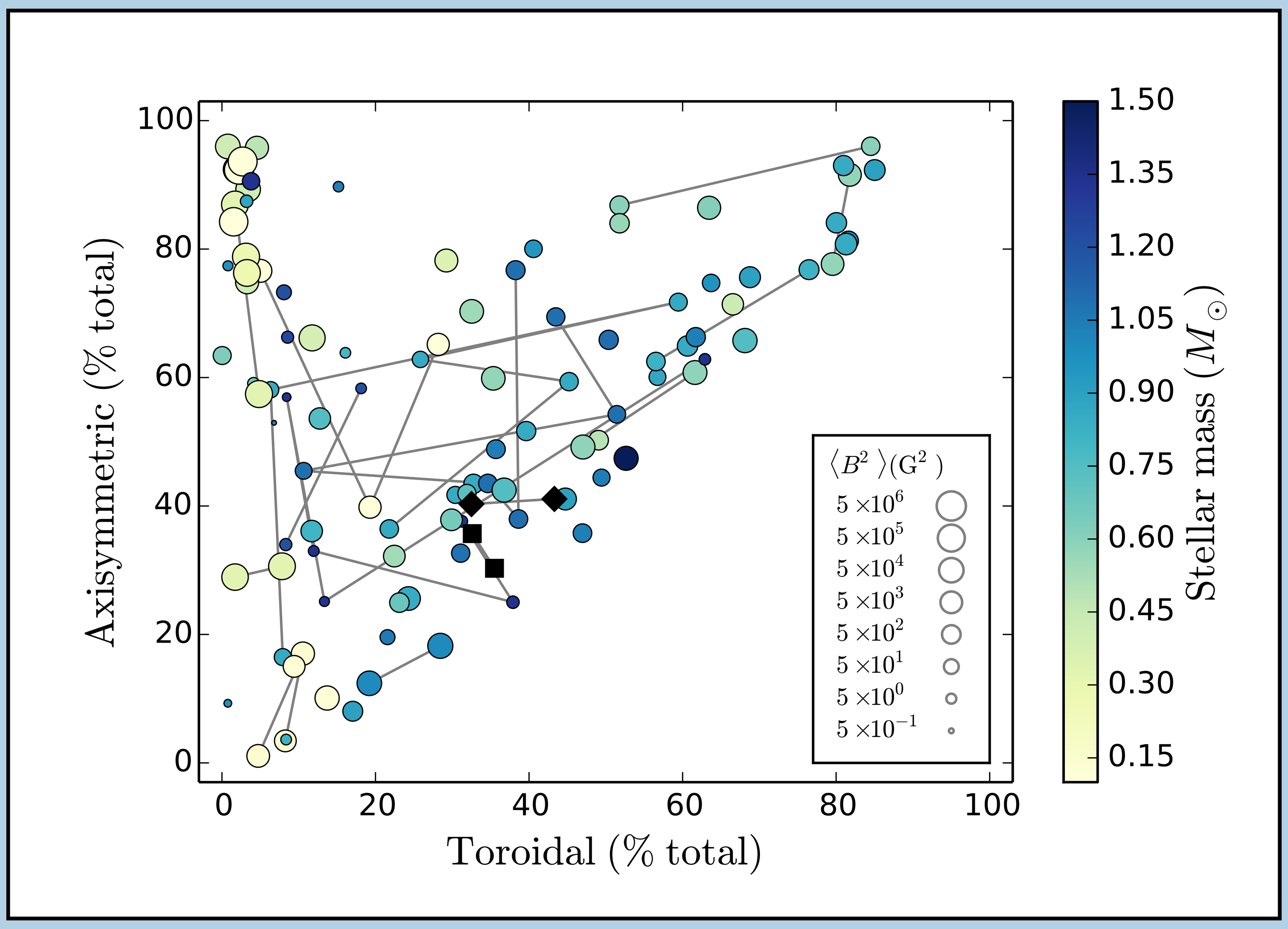
Stellar magnetic fields are generated by dynamo mechanisms deep inside the stars. However, the type of dynamo cannot be the same for every star. It depends on the internal structure of the star which, in turn, depends on the stellar mass. In the Sun, for example, it is thought that field generation primarily occurs in a thin layer between the radiative core and the outer convective zone. This type of dynamo cannot operate in very low mass stars that are fully convective and therefore lack such an interface. The differences in the underlying dynamo manifest themselves in the properties of the magnetic fields at the stellar surface. Using Zeeman-Doppler imaging (ZDI), the strength and geometry of stellar magnetic fields can be mapped. In this poster, we use ~100 Zeeman Doppler maps to probe the underlying dynamos of ~50 stars.

Field geometry

The magnetic energy at the stellar surface can be broken down into various components that reflect the geometry of the magnetic field. The most commonly used components are the poloidal/toroidal components as well as the axisymmetric component.



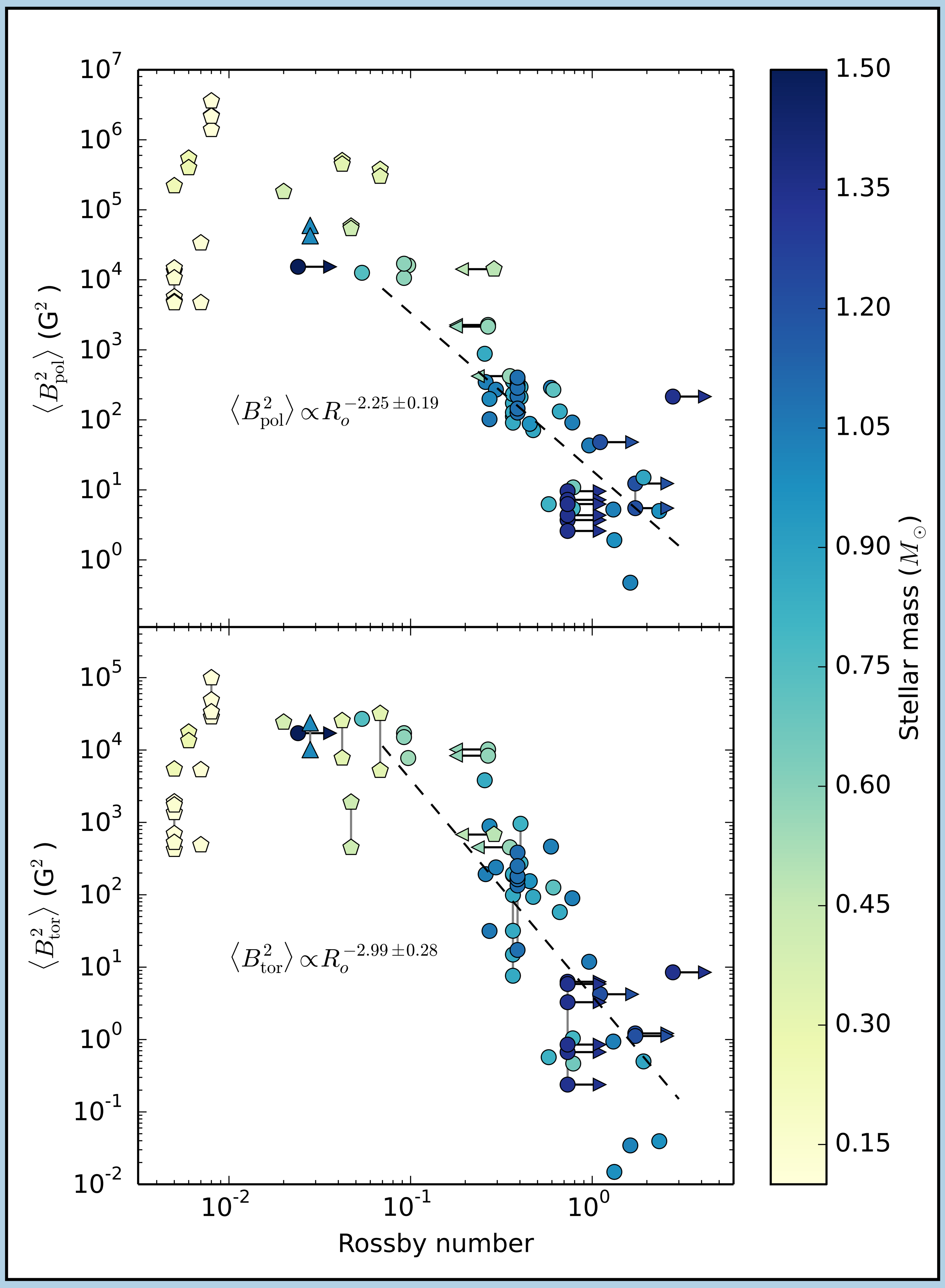
When plotting the the toroidal magnetic energy against the poloidal magnetic energy, we find that the sample splits into two subsamples. Stars more massive than 0.5 M☉ (circles) are able to generate toroidal field more efficiently and follow a different power law to stars less massive than 0.5 M☉ (pentagons). This change in power laws is likely due to a change in internal structure as stars cross the fully convective boundary. See poster by Lisa Lehmann for further discussion.



When plotting the percentage of magnetic energy in axisymmetric modes against the percentage of magnetic energy that is toroidal, we find that the most toroidal stars also have the most axisymmetric fields. This is a strong indication that toroidal fields are generated via differential rotation - an axisymmetric field generation mechanism.

Saturated and unsaturated regimes

The poloidal and toroidal components both follow the well known activity-rotation relation from X-ray studies. Both display the unsaturated and saturated regimes with the transition occurring at a Rossby number of ~0.1. The similarity between the two plots indicates that the poloidal and toroidal fields are generated from each other.



Conclusions

In this poster, we have analysed ~100 ZDI maps of ~50 stars. This is the largest sample of stars gathered to date to study the behaviour of toroidal fields as a function of various parameters.

We find that that the magnetic field strengths follow the activity-rotation relation. This provides another link between X-ray emission and the magnetic fields that generate them.

We also find that the internal structure of a star affects the relative strengths of the poloidal and toroidal components. Fully convective stars appear to be remain dominantly poloidal whereas stars with radiative cores are able to generate dominantly toroidal fields.

Lastly, we find that the most toroidal stars also have the most axisymmetric fields. On the other hand, the orientation of the magnetic axes of dominantly poloidal stars appear to be unconstrained relative to their rotation axis.

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