Measuring sizes and compactnesses of Young Star Clusters

Peter Anders (1), Mark Gieles (2), Richard de Grijs (3), Uta Fritze - v. Alvensleben (1); *(1) Universitäts-Sternwarte Göttingen, Germany, (2) Utrecht University, NL, (3) University of Sheffield, UK*

We present our recent efforts to improve the **size determinations** and **photometry** of star clusters. This also involves **size-dependent aperture corrections**, which turn out to depend considerably on the structural properties of the young star clusters.
On the basis of these reliably measured sizes we define a useful observable measure of the compactness of a star cluster, which also describes how strongly it is bound and hence governs its survivability during the evolution of the host galaxy. This compactness and survivability is of major importance for the studies of young star clusters in interacting/merging and starbursting galaxies, since it will significantly help our understanding as to which of these clusters will eventually resemble Milky Way Globular Cluster-type objects. From our studies we can draw conclusions e.g. about the relation between the cluster properties (compactness, masses ...) and the properties of the starburst in which they are born. This will also improve our understanding about the evolution of galaxies from high redshifts to the present.
We will show applications of our new tools to the young star cluster system in the Antennae galaxies.
In addition, we give an outlook to a near-future spectrophotometric metatool, the **Legacy Tool**, connecting a large number of existing models in this field.

Gieles, Anders & de Grijs (2004), part I: size determination

We simulate *HST* observations of star clusters using artificial clusters with:
- different **cluster light profiles** ([tidally truncated] KING models as for old globulars with various concentration indices, [untruncated] Elson profiles as for young clusters in the Magellanic Clouds with various power-law slopes)
- different *HST* **filters**, different **cameras** (WFPC2, ACS WFC, NICMOS NIC2), different **chips/chip positions**
- **fitted with a Gaussian profile**, as this is the easiest and most robust size measure
- a useful range of cluster radii

and investigated the impact of :
- different **fitting radii**
- different amounts of **noise** (source shotnoise and sky background)
- **cluster brightness**, including the resulting **errors for the size determination**

Results: (one example shown in Figure 1)
- There are some systematic offsets for different chips and filters, which are most pronounced for NICMOS.
- Cluster brightness does not affect the measured sizes, only the measurement errors.
- We fit polynomials to our results to allow the **conversion of measured cluster sizes to intrinsic** ones.

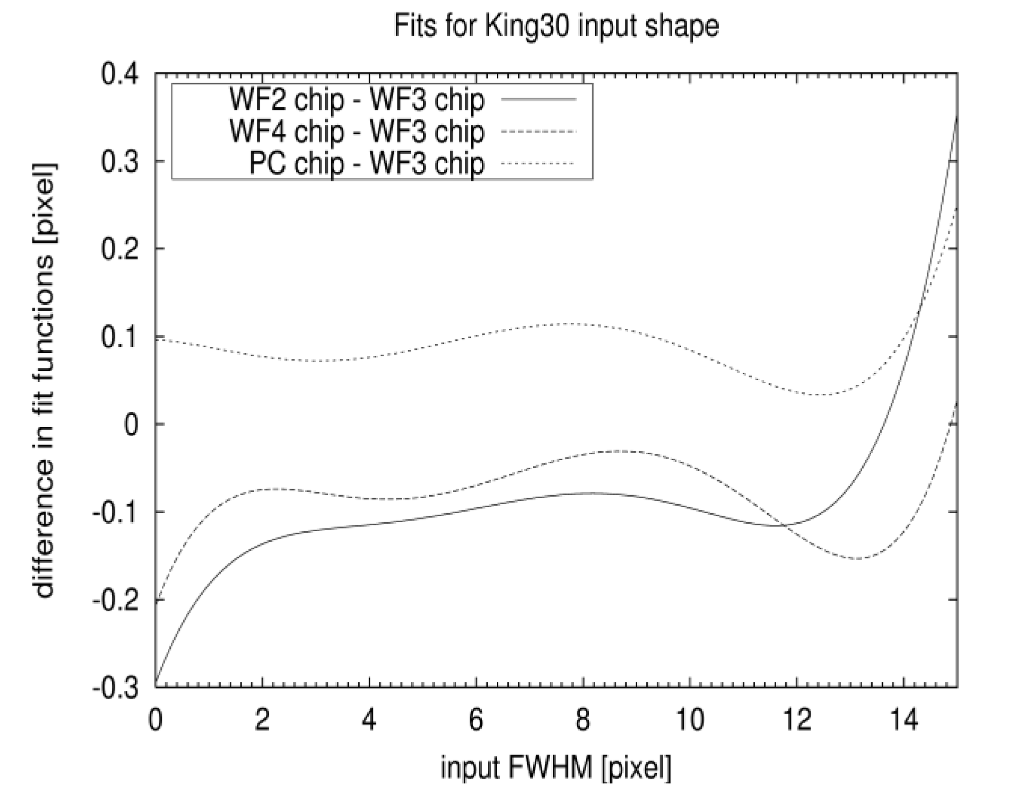

Figure 1: Differences in size conversion relations for different WFPC2 chips, with respect to the WF3 chip.

Gieles, Anders & de Grijs (2004), part II: size-dependent aperture corrections

For the same clusters we did the size determination with, we determine fluxes in various apertures. From these fluxes we calculate the **size-dependent corrections needed to correct for the TOTAL flux of a cluster**.

Aims of the whole project (parts 1 & 2)

- improve present size determinations, evaluate our accuracies
- improve present aperture corrections by taking the source size into account (see Figure 2 for the huge impact!)
- give a measure of the compactness, and hence survivability of a cluster, using the improved sizes and photometry

This results in
- higher overall magnitudes, hence higher masses of the clusters
- differential corrections along the **s**pectral **e**nergy **d**istribution of a cluster, hence a correction in the parameter determination of the clusters

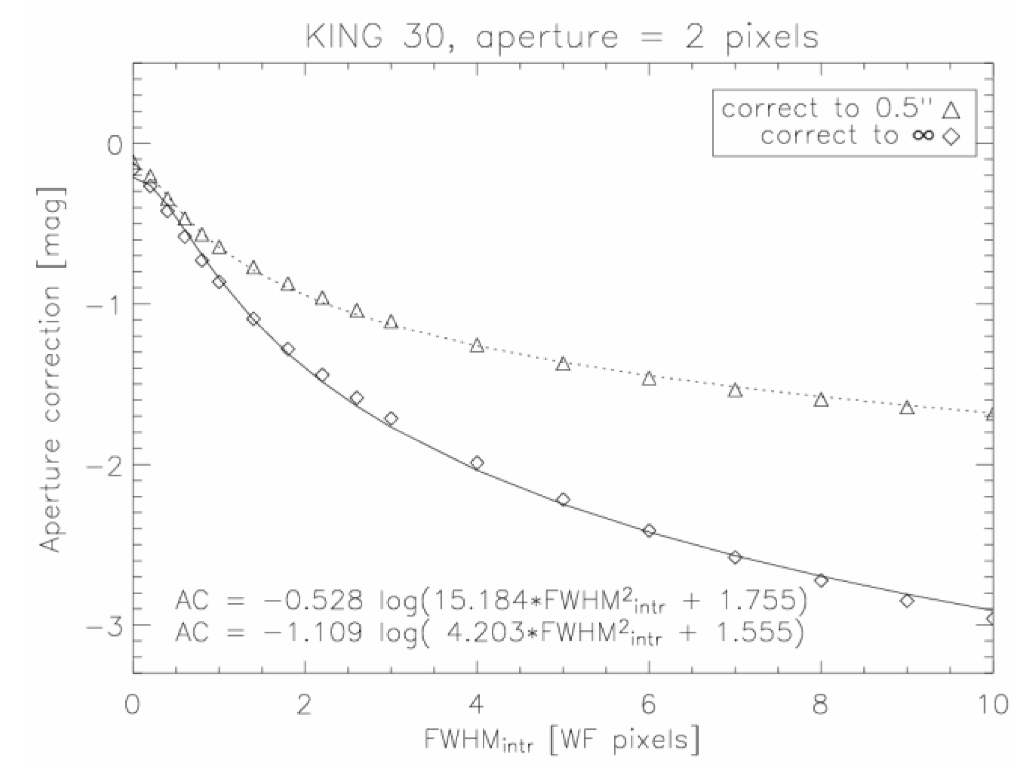

Figure 2: Example of aperture corrections.

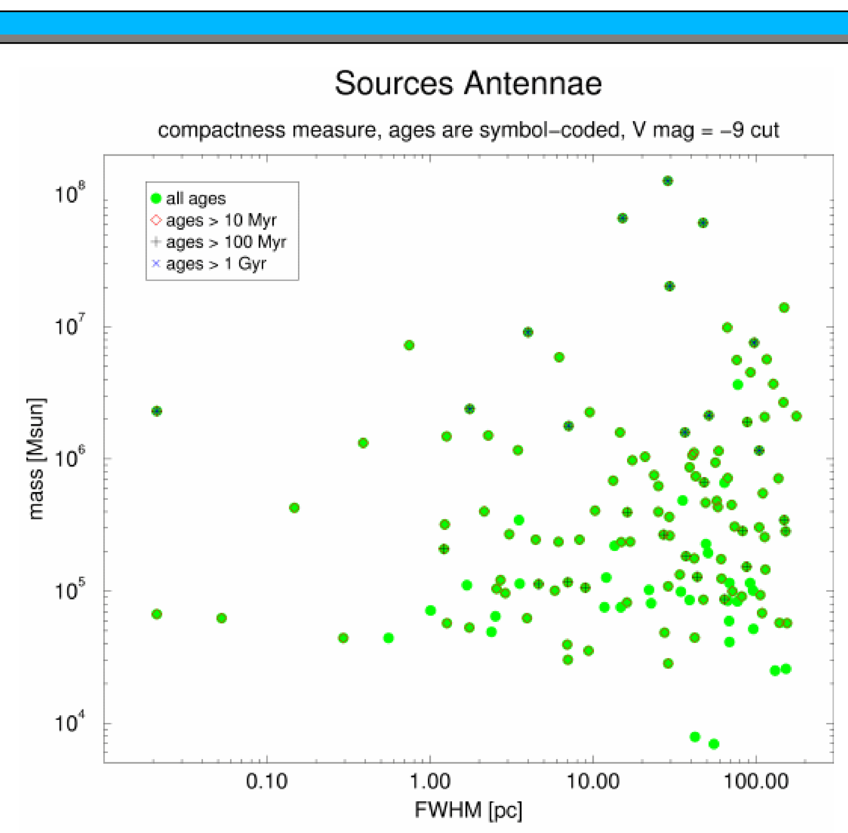

Figure 3: Sizes and masses, together a measure of compactness of a source, of sources in the Antennae galaxies. The ages determined for the sources are indicated by different symbols.

First application

We have applied our size determination and aperture correction tool to a subset of sources in the Antennae galaxies. These sources have all absolute V band magnitudes brighter than -9, hence the contamination by bright evolved stars should be small. Cluster parameters were determined as described and evaluated in Anders et al. (2004a).

As can be seen from Figure 3, the compactness parameter space is homogeneously occupied within the ranges observed, with no signs of age effects (except the expected evolutionary fading). No open vs. globular cluster dichotomy is observed. See Anders et al. (2004b) for details.

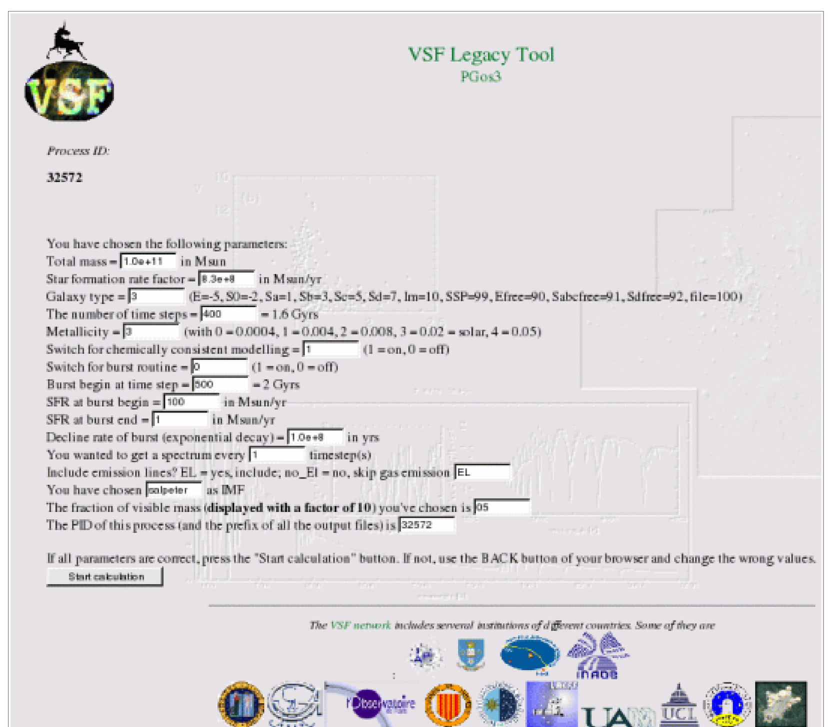

*Figure 4: Screenshot of a preliminary version of the soon-available **Legacy Tool** of violent star formation*

PGos3 by M. Cerviño, E. & R. Terlevich, A. López, V. Luridiana, A. Bressan, C. Morisset, P. Anders et al.

A star formation metatool

The violent star formation community is in the process of establishing a metatool incorporating and linking a number of existing programs from various groups, e.g. for stellar libraries, evolutionary sythesis codes, photo-ionization codes etc. This tool called **Legacy Tool** (or in the preliminary version **PGos3**) will allow to easily access and compare different models and model inputs, and provide a continuous pipeline from the input data through a set of models (like libraries → evolutionary synthesis → photo-ionization) to a final output to be compared with observations. The release of the preliminary **PGos3** version is expected for beginning of 2005. See "Welcome" @ **http://dae.iaa.es/PGos3/** for credits and further information!

References:
Anders P., Bissantz N., Fritze – v. Alvensleben U., de Grijs R., 2004a, MNRAS, **347**, 196
Gieles M., Anders P., de Grijs R., 2004, *in prep.*
Anders P., et al., 2004b, *in prep.*

Email: panders@uni-sw.gwdg.de
Galaxy Evolution Group webpage: http://www.uni-sw.gwdg.de/~galev/