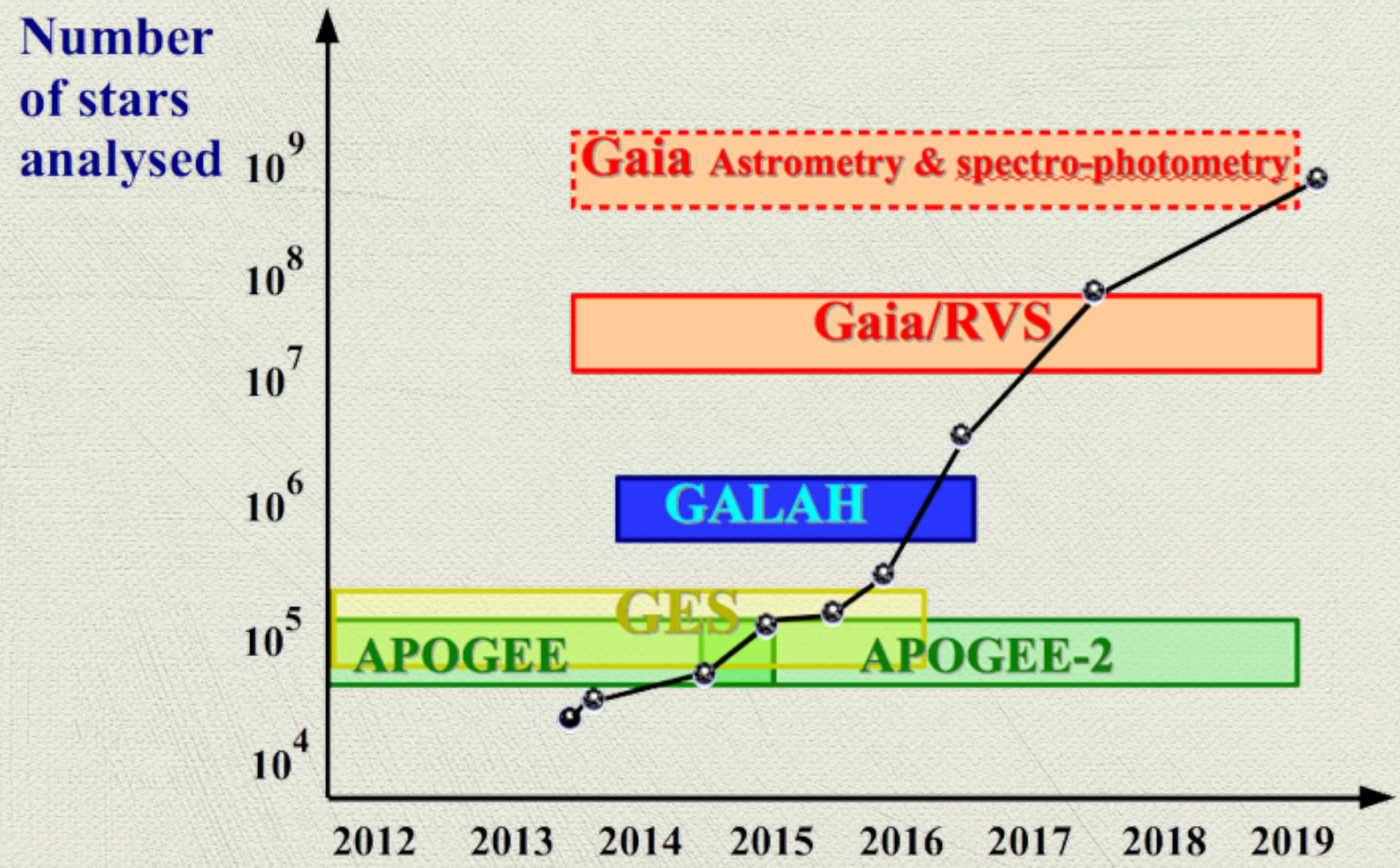
Galactic archaeology in the Gaia era



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Automated spectrum analysis

Huge numbers of spectra: automated analysis procedures needed



Automated spectrum analysis

Mathematical approaches of parametrisation

Optimization

Parameters derived through a distance minimization

e.g. Minimum distance, Nelder-Mead, Gauss-Newton (**GAUGUIN**), Penalized chi2

Projection

Spectra projected into vectors derived during learning phase

e.g. **MATISSE**, PCA (MOPED, MaX)

Classification

Pattern recognition problem

e.g. Decision trees (**DEGAS**), Neural networks, Support vector machines

Automated spectrum analysis

- **MATISSE** : **Recio-Blanco et al. 2006**

  Projection method. Local multilinear regression

Stellar parameters
Teff, logg, [M/H], [alpha/Fe]

Observed spectrum

$$\hat{\theta}_i = \sum_{\lambda} B_{\theta_i}(\lambda) O(\lambda)$$

Application phase

Synthetic grid spectra

$$B_{\theta_i}(\lambda) = \sum_{j} \alpha_{ij} S_j(\lambda)$$

Correlation matrix
$c_{ij} = S_i S_j$

$$\Theta_i = C\alpha_i$$

Training phase

Automated spectrum analysis

- **DEGAS : Kordopatis, Recio-Blanco et al. 2011**

Pattern recognition method. Oblique k-d decision tree

Decisions = projection of data into node vectors D_n

Observed spectrum

$$c_i = O_i \cdot D_n$$

Application phase

Synthetic grid spectra

Median of spectra with $c_j <$ median (c_j)

Median of spectra with $c_j >$ median (c_j)

$$c_j = S_j \cdot D_n$$

$$D = M_1 - M_2$$

Training phase

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- **GAUGUIN** : **Bijaoui, Recio-Blanco et al. 2012**

Optimization method. Gauss-Newton algorithm

Linearization around a parameter set Θ associated to a theoretical spectrum $\mathbf{S_0}$. Corrections obtained with:

Observed spectrum

Synthetic spectrum

$$\delta\Theta = (\mathbf{J}^T\mathbf{J})^{-1}\mathbf{J}^T(\mathbf{O} - \mathbf{S}_0)$$

Jacobian matrix $[\partial S(l,\ \Theta(0)\ )/\partial \theta i]$

Used after MATISSE, DEGAS or photometric parameters

Automated spectrum analysis

Methods already applied to:

CoRot follow up: 1300 spectra

Disc archaeology (VLT PI programme): 700 spectra

Gaia-ESO Survey (Giraffe HR10, 21; UVES): 60 000 spectra

ESO archival spectra (AMBRE project): 200 000 spectra

RAVE survey: 430 000 spectra

Gaia/RVS : ~150 million spectra

Under testing for: **4MOST@VISTA (ESO) pipeline**

Automated spectrum analysis

