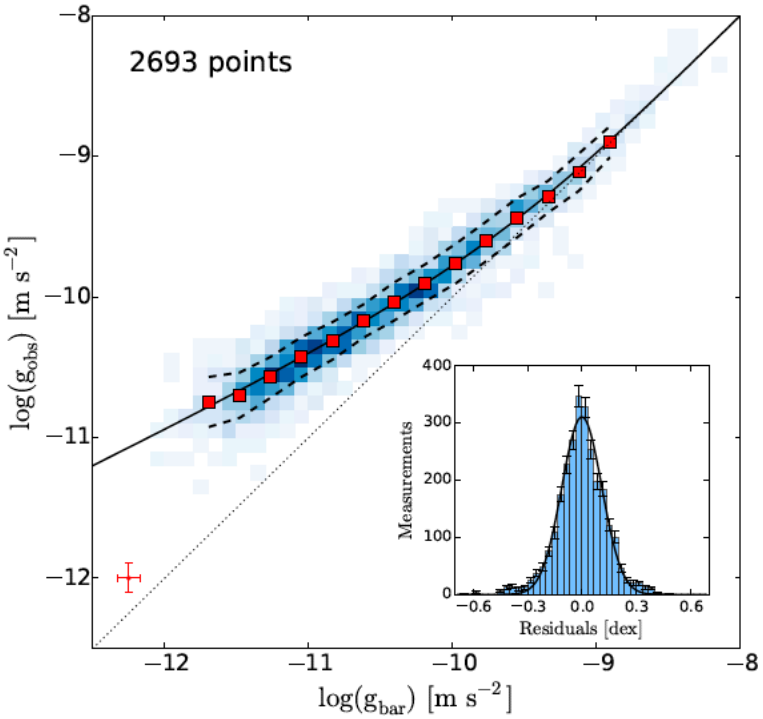
ICRAR & ICRAR-Pawsey Summer Studentships 2018-2019
Project Proposal

Project Details	
Project Title	**Dark Matter and the origins of MDAR: the Mass Discrepancy Acceleration Relationship.**
Primary Supervisor	Prof. Gerhardt R Meurer
Primary Supervisor Availability	Prof. Meurer expects to be present during the entire studentship period.
Contact Details	08 6488 7728 (o) 043 305 2558 (m) gerhardt.meurer@icrar.org
Additional Supervisors & Contact Details	A/Prof. Aaron Ludlow 044 956 7248 (m) aaron.ludlow@uwa.edu.au
Additional Resources Required	nil
Pawsey Centre Hardware Use	not required
Software Required	IDL (including the *astrolib* package) or python (including the *matplotlib* package) will be used in this project. A workstation having all of these installed would be most ideal for the student.
Student Location for project	ICRAR-UWA
Project Description	One of the biggest mysteries in astrophysics concerns "Dark Matter". Evidence shows it is the dominant form of mass in the Universe. However, we know little about its composition because it emits little or no light, hence we call it "Dark". Instead, we infer its presence in galaxies from their dynamics – more mass is required than observed. Following the discovery in the 1970s of the problem of missing mass in galaxies, the "Cold Dark Matter" theory was developed and gives our best understanding of the nature of Dark Matter. An alternative to requiring Dark Matter is that maybe the the force of gravity does not have a simple $1/r^2$ Newtonian fall off with radius. This has led to the MOdified Newtonian Dynamics (MOND) prescription for the gravitational force law. Recently McGaugh et al (2016 https://arxiv.org/abs/1609.05917) showed that MOND predicts a very tight relationship between the observed gravitational acceleration in galaxies and that expected from their normal matter (the mass discrepancy acceleration relationship or MDAR, see figure below), which they claimed could not be easily accounted for in standard models of galaxy formation and evolution which include Dark Matter. In this project we will test a scenario, the "stable disk model" for galaxy evolution that fits in well with the Cold Dark Matter theory and may account for MDAR.

	 The MDAR relationship of McGaugh et al. (2016).
Student Attributes	
Academic Background	Second year physics and reasonable math skills are required. More specifically: the candidate should be comfortable working with algebra and simple calculus (derivatives and integrals).
Computing Skills	The candidate should have some experience and skill in scientific programming, preferably using python or IDL. The candidate will most likely use a computer running OSX for Macintosh computers.
Training Requirement	Some training in the science and programming may be required.
Project Timeline	
Week 1	**Pawsey training (or inductions and project introduction)**
Week 2	Define fiducial rotation curve, and optical galaxy scaling relation models; code these as a function of relevant parameters.
Week 3	Fit: determine halo + stable disk models required to fit these relations. Iterate as needed.
Week 4	More fitting as in Week 3
Week 5	Derive Mass Discrepancy Acceleration Relationship (MDAR) for models, compare to observations.
Week 6	More comparisons with observations, as in Week 5, if needed, otherwise start writing.
Week 7	Write results: paper outline, gather refs, start filling in.
Week 8	Write results: finish first draft, give to advisers.
Week 9	Tweak draft, create final draft, submit to journal.
Week 10	**Final Presentation and Reporting**