

# Investigation 1

## Abstract

*This document outlines the process of conducting a simple investigation into an astronomical topic. Mechanisms of researching the data/literature are discussed and a number of example sources are presented. A detailed discussion of how to check the authenticity, academic level and quality of the information is given. The second part of the document discusses how to write a scientific literature review using the researched topic. Ideas presented here will help you assess the correct level of material then focus in on a theme that can be realistically developed and argued within the limits set. Finally, adding an abstract (similar to this one) or executive summary is discussed.*

## The Astronomical Distance Ladder

### Introduction

The first investigation is *The Astronomical Distance Ladder*. This topic has been deliberately set to build upon and move beyond the scope of both the Courses Notes and recommended textbooks in our Astronomy and Cosmology courses. The notes for *Introduction to Astronomy*, *Introduction to Cosmology* and *IT for Astronomy* are provided via WebCT and on CDRom. The first two courses introduce the concept of the astronomical distance scale but due to the pressure of other topics it is was not possible to provide a comprehensive introduction. However, it would be wise to read the appropriate sections again to determine the breadth and depth of your investigation.

The report for the first investigation is deliberately limited to a maximum of 1000 words which will require great selectivity in defining the scope of your report. The module Aims and Objectives also say you have the “opportunity to conduct in-depth study through your independent research”. This means, to reach the right level (first year undergraduate), you will have to work hard at the depth despite the short word limit. For the first investigation we provide a detailed outline of the investigative process which you can follow. For the other assessments you will be expected to do your own research. In the first assessment you will read the information and write the report. Finally, before you begin you should read the Learning Outcomes as stated in the [Module Description](#).

### Researching the topic

To do well at this module, and other research topics, you are advised to maintain a research log. A hard-backed note book is ideal. You should record everything that you do, so that you (or anyone else), could speedily repeat the investigation if necessary. In particular make detailed notes on whether the information sources are use or not.

You will not normally be required to hand-in your research log for assessment but you should retain your work in case of problems.

The principal sources of information are a library and the internet. In Assessment 1 this document will outline the process of researching a topic (Learning Outcome 1 in the module description). You will only be assessed on Learning Outcomes 2 – 4 as the research has been demonstrated within this description. For clarity and reasonable uniformity this outline will focus on the use of the internet as a primary information source. (For those who do not have the internet at home you can gain access at most libraries.) If you repeat the internet searches you should get very similar results to those described here.

## Search Tools

The main tool for extracting information from the internet is a search engine running within a browser. (See [Section 3 of the IT for Astronomy Notes](#)). Some of the most popular search engines are summarised in [Table 1](#). It is important to realise that different search engines work in different ways. Some classify documents by looking at the title and placing the result in a large directory, others work by counting words in the document and other use the keywords and document description embedded in the hypertext document. Common sense dictates that you will make use of several search engines to gain a broad picture of the information sources. The information that you record in your logbook will reflect this. If you feel that the search engines listed here are limited then you can use one of them to locate others by searching for “internet search engines”.

**Table 1. Internet Search Engines**

<a href="http://www.yahoo.co.uk">www.yahoo.co.uk</a>	Not the option to run in advanced mode
<a href="http://www.altavista.com">www.altavista.com</a>	Options to refine the search and home-in on a topic.
<a href="http://www.google.co.uk">www.google.co.uk</a>	Similar to Yahoo offering advanced searches and search within search results.
<a href="http://www.msn.co.uk">www.msn.co.uk</a>	Also with Advanced Search
<a href="http://www.ask.com">www.ask.com</a>	May also give provide sponsored results based on one or more words entered.
<a href="http://www.metacrawler.com">www.metacrawler.com</a>	Uses the hidden meta tag descriptions/keywords in the html

There are variations on these web addresses that depend on your country of origin. Some sites will reroute you to the main local site. Some search sites are powered by the same software and will therefore return (very) similar results. For example your service provider might provide a search facility that displays a phrase “powered by Google™”.

The [University Library](#) offers a wealth of information on electronic information about astronomy. In addition to the general search engines you will be able to locate specialist internet search software. For an introduction to the wide range of search engines available consult Search Engine Guide [<http://www.searchengineguide.com>]. You could use this site to determine the different types of internet search engines to ensure that you include at least one from each category. This site has a page devoted

to astronomy resources (usually in the form of a directory). Some of these sites will be referenced by the general search engines. Not all of these sites are reliable and this is discussed in detail below.

## **Step 1 – Preparation of search terms**

In your logbook prepare a list of key words and phrases that will form the basis for the initial investigation. These ideas are drawn from the Astronomy and Cosmology Course Notes and the [recommended textbooks](#) for Introduction to Astronomy and Introduction to Cosmology.

A good start is to use the title given. Other words in the Course Notes will help you focus the investigation as will the suggestions in this document. Suggested search terms used in the guidance below include:

- Astronomical distance ladder
- Astronomical distance
- Astronomical distance scale
- Extragalactic distance scale
- Cosmic distance scale

Not all search engines (listed in [Table 1](#)) work in the same way so you could replace astronomical with astronomy in an attempt to keep the search as general as possible. Keep the key words count to a minimum.

## **Step 2 – Testing the search engines**

Once you have a list of key words and phrases try each of the search engines in turn to assess the volume of material available. Use your initial phrase to expand the list of key words. At this early stage you might want to limit the search by looking only at the first page of results returned and noting only key phrases or titles. Again plan this in advance by sketching the strategy in your logbook. (If you go on to study at a more advanced level you may be asked to return your logbook as proof of originality of work and to demonstrate the development of your thoughts. In exceptional cases your University Tutor might ask to see your logbook or your rough working if you get into difficulty with the assessments.)

a) Yahoo with “astronomical distance ladder”

This search returns many results that are similar to our original list but with one or two extra ideas. Notably, “Standard Candles”, “cosmological distance”, and the idea of measuring and estimating distance.

b) Yahoo with “astronomical distance scale”

Provides “Cepheid Distance Scale. A History” and “parallax” both these concepts are mentioned in the course notes.

c) Google with “astronomical distance ladder”

This search reveals nothing new but confirms “parallax” and “standard candles” as linked to the subject.

d) Google with “astronomical distance scale”

This page highlights “Hubble’s Law” and also suggests that the distance scale is one of the great debates in astronomy. This is one of the reasons why we selected this topic for the first assessment in this module.

e) Altavista with “astronomical distance scale”

This search engine returns slightly different results to the others. First is the “Venus Transit 2004 – Introduction” which clearly indicates that there are different parts to the distance ladder. Also present here are words such as “distance indicators” [don’t use this out of context]. And “distance estimation”.

Note that altavista gives options to refine the search (on the right of the screen) which lists “calibrate” as one of the options. At this point you will have a feeling about which search engines you prefer and you should be able to draw up a revised list of key words and possibly restrict the number of search engines to be used.

### **Step 3- Check reliability and authenticity**

Having used the search engines to collect additional key words and assess the volume of information a more serious investigation is required. All search engines return many thousands of results which would be impossible to condense into 1000 words. Additional criteria must be applied to allow a much smaller sample to be generated. You must be aware that anybody can publish a web page so you must check that the information is accurate and reliable. Given that the report is at level 1 (university first year undergraduate) many popular pages can be rejected. It would be unwise to include pages:

- targeted towards schools (e.g. K12) and public understanding of science (PUST) even if published by NASA or a similar organisation
- developed by amateur astronomers
- hosted by institution with no academic (research) credibility

Surprisingly the initial searches conducted here did not include any [Scientific American](#) articles. It might be worth including articles that appear in [Sky and Telescope](#). Most pages published by universities and observatories would normally be regarded as reliable sources. However, check the references and sources of information that are quoted in the article. Your report will only be approximately 1000 words in length which means it is not necessary to produce an exhaustive search of the literature. If you have access to a university library [Annual Reviews](#) also contains research and literature reviews.

### **Step 4 - Identifying substantive content**

In this phase we have to identify sufficient content to be able to write a coherent report. It was clear from the first steps that the subject area is very large and it would be difficult to write a comprehensive review within the word limit. In order to work within the brief of 1000 words and university level 1 we should limit the scope in some way. Your report must demonstrate that you can develop and explore an argument. With this in mind we could consider the following themes:

- One part of the ladder

- Calibration
- Methods
- Future techniques
- Historical developments

An internet search based on the keywords listed above will lead to the following information and much more.

Steps to the Hubble Constant

[<http://www.star.ucl.ac.uk/~idh/STROBEL/galaxy/galaxyd.htm>] provides a good summary and will give you a clear idea on how you might tackle a report that deals with one part of the distance ladder.

The Universe and the Curtis-Shapley Debate: Lecture

[[http://www.imsa.edu/edu/astro/astronmetry/historical/debate\\_1920a.html](http://www.imsa.edu/edu/astro/astronmetry/historical/debate_1920a.html)].

The Cepheid Distance Scale: A History Written by an MSc student [<http://institute-of-brilliant-failures.com/index.htm>].

Great Debates in Astronomy

[[http://antwrp.gsfc.nasa.gov/diamond\\_jubilee/debate.html](http://antwrp.gsfc.nasa.gov/diamond_jubilee/debate.html)] demonstrates why a discussion of the distance scale is important to astronomy. The 1996 debate "The Scale of the Universe" will be our primary source of information. Take a look around the links from this webpage; some are more reliable and accurate than others

## The Assignment

1. Follow the procedures outlined in this document to ensure that you can repeat this process for Investigations 2 and Investigations 3. (The research procedures will not be assessed for Investigation 1.)
2. Read and make your own notes on the information given in the Jubilee Debate on the *Great Debates in Astronomy* website [[http://antwrp.gsfc.nasa.gov/diamond\\_jubilee/debate96.html](http://antwrp.gsfc.nasa.gov/diamond_jubilee/debate96.html)].
  - Identify a subject theme from these publications. Ideally it will have 2 or 3 sub-topics. Remember that to discuss and explore one small topic will require about 200 - 300 words. Can you draw any conclusions of your own?
  - Decide on the approach you will take. For example will you present two or three detailed arguments and then write a conclusion or will you take a blow-by-blow account of the two themes. Select an appropriate title.
3. Write a report on the **Astronomical Distance Ladder** using the specified articles and information given in the above (Jubilee Debate) link. Your report should have an introduction that sets out the wider context of the subject followed by an introduction to the report which will say how you intend to limit and focus your discussion. The report should also have concluding remarks possibly accounting for up to 200 words. Section 5 of the *IT for Astronomy Course Notes* discusses how to produce scientific reports and Appendix .A discusses organisation of the scientific content

4. Finally, add an **abstract** of no more than 65 words to the report. This should state what you have done, how you did it and the main conclusion. It should be treated a little like an executive summary and will require no technical background. As an example of a good abstract read the abstract to the paper *The Scale of the Universe: A Curtain Raiser in Four Acts and Four Morals* by Owen Gingerich PASP 1996, vol.108, p.1068, available from the website above.
5. Your report should also contain a complete list of references used. (This is not included in the word count)
6. Submit the assignment via WebCT Assignments.