



Reclaiming the Astronomical and Historical Legacy of Antonia Maury (or Two Stars, Two Sisters, Two Sciences)

Kristine Larsen

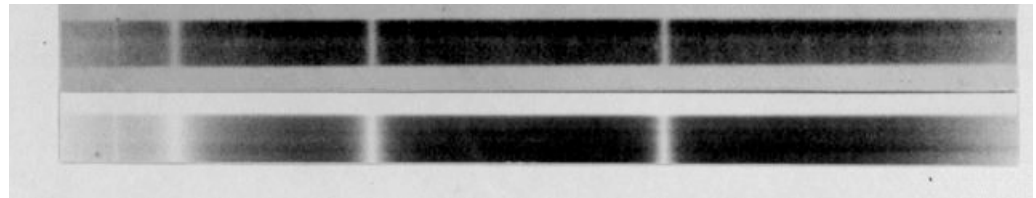
Physics and Earth Sciences Dept. Central
Connecticut State University

The standards facts

- ▶ **Antonia Caetana de Paiva Pereira Maury born March 21, 1866 to Reverend Mytton Maury and Virginia Draper (sister of famed amateur astronomer Dr. Henry Draper)**
- ▶ **Was a student of Maria Mitchell at Vassar**
- ▶ **After graduation in 1887, began work at the HCO as part of the Henry Draper Memorial Project**



- ▶ Was given task to classify bright northern stars according to the Fleming categories (A-Q)
- ▶ Found that the classes needed to be rearranged by temperature (B before A) and that stars of the same temperature class had differences in their spectra
- ▶ Developed new system I-XXII with “c-characteristic”
 - a: lines wide and well-defined
 - b: lines wide but hazy
 - c: H and He lines were narrow and sharp with intense Ca lines



Butting heads with Pickering



- ▶ Pickering's philosophy "it is seldom necessary in such investigations as are carried out here, to form a theory in order to learn what facts are needed"
- ▶ According to Dorrit Hoffleit, Maury was "pure intellect", "the more intellectually gifted", and "the most original thinker of all the women Pickering employed; but instead of encouraging her attempts at interpreting observation, he was only irritated by her independence and departure from assigned and expected routine." (various writings)

Leaves HCO @ 1891-2 with project unfinished, returns several years later and *Spectra of Bright Stars Photographed with the 11-inch Draper Telescope as part of the Henry Draper Memorial* finally published in 1897 (*Annals of the Astronomical Observatory of Harvard College Observatory* 28 Part 1)

Included “divisions” of a,b,c according to line appearance, as well as notation of stars of “composite spectra” which “seemed in reality to result from the combination of the spectra of two or more close components of different spectral characteristics”



Pickering did not support her system, favoring Cannon's 1901 "OBAFGKM" system

Meanwhile Hertzsprung realized Maury had found evidence of what we now call "luminosity classes" (giants and main sequence stars) and urged Pickering to include her c-characteristic

"In my opinion the separation of Antonia C. Maury of the c- and ac- stars is the most important advancement in stellar classification since the trials of Vogel and Secchi.... To neglect the c-properties in classifying stellar spectra I think, is nearly the same thing as if the zoologist, who has detected the deciding differences between a whale and a fish, would continue in classifying them together" (1908)

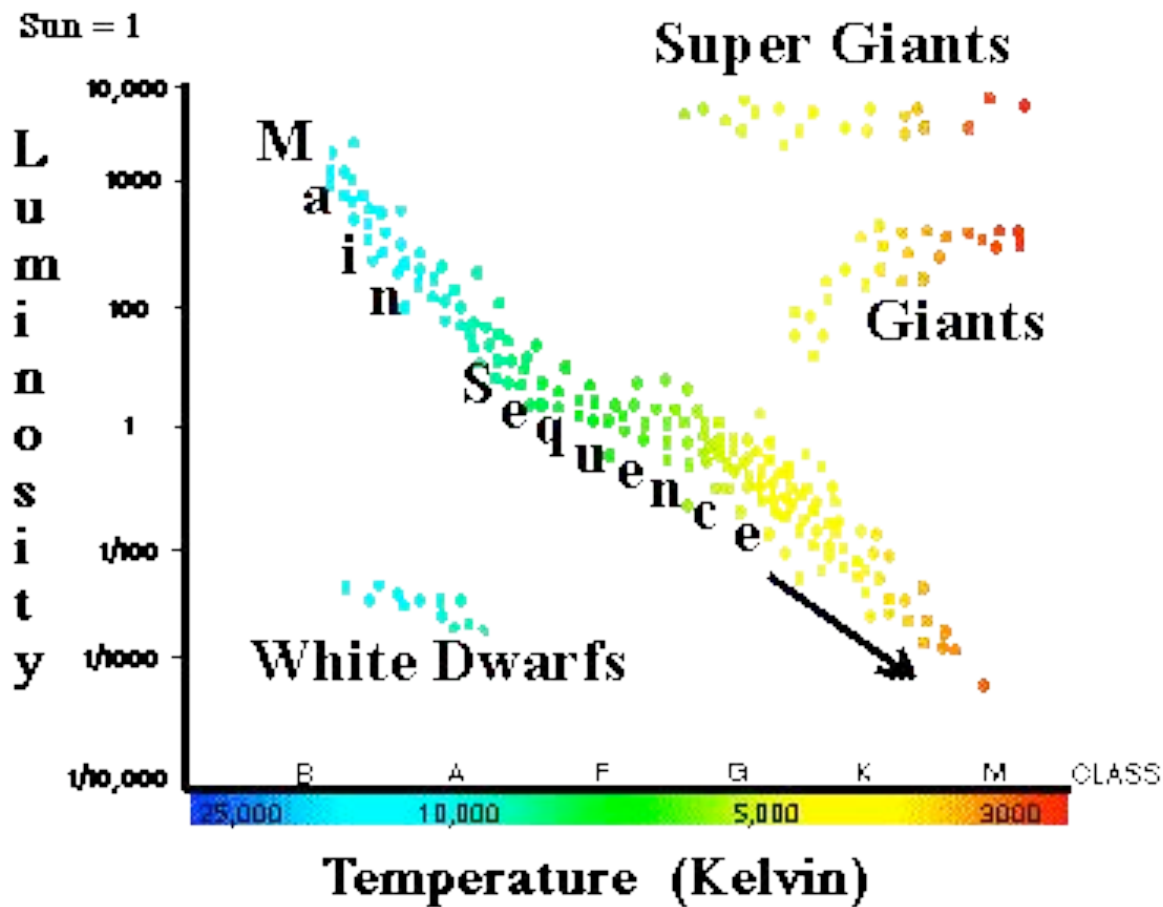


Pickering didn't buy it (equipment wasn't good enough to see it)

(or, as Dorrit told me in 1994, “it wasn't that he couldn't see them... he was miffed that she was the one that discovered something.”)

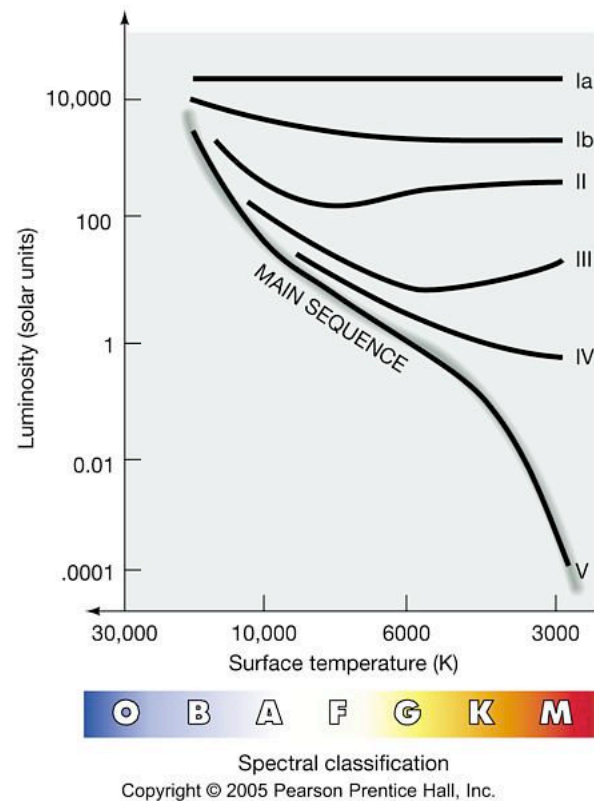


The result.... The HR diagram



As Dorrit wrote in 2002, “If only Pickering had appreciated Maury’s conclusions and accepted and acted upon Hertzsprung’s remarks, a two-dimensional system could have evolved at Harvard over 30 years before the currently preferred MK system.”

[Maury left HCO after completing her paper, not to return until 1918 (just before Pickering’s death) and spent the intervening years lecturing and teaching high school.]



1993–1995: Women in the History of Astronomy – where are they?

Survey of introductory textbooks 1960s-1990s:
inclusion of women by name

Cannon: 67%

Fleming: 13%

Maury: 11%



October 1994 Interview with Dorrit

“She could talk about every subject imaginable”

“She was that way with almost every subject matter that came up, it didn’t have to be astronomy”

“Yes, I’m very fond of her”



“She was just a cultured lady in everything except personal appearance”

“Generally her heels [in her worsted stockings] were always showing through.”

“some youngster that lived in the Hastings talked about her, how she was so badly dressed, grease on her dress or something, completely oblivious.”

“She was very homely; that was one of her drawbacks, I suppose.” (CP-G)



“the most original as well as the most elusive personality among the women astronomers in Harvard” (Jones and Boyd)

“a dour and talented astronomer whose physical insights and boredom with drudgery did not well fit her for the routine work of spectral classification” (Dobson and Bracher)

“I strongly disagree with the implications of this verdict. The word ‘dour’ is not a synonym for ‘unhappy’.” (Hoffleit)



“Miss Maury was sensitive, imaginative, affectionate, and I feel as if she was a rejected sort of person. I don’t know if anyone had ever shown her much affection.... Nobody had ever listened to her.... She was a woman of great courage and warmth of heart” (CP-G)

“the single greatest mind that has ever engaged itself in the field of the morphology of stellar spectra” (W.W. Morgan’s dedication to her, Atlas of Spectral Classes)



“Verses to the Vassar Dome” (*Popular Astronomy*, 1923)

“And they that scan the
 heavens by night,
Since truth’s clear light
 they saw,
No human meets and
 measures serve,
But Nature’s mightier
 law.”
(1896)

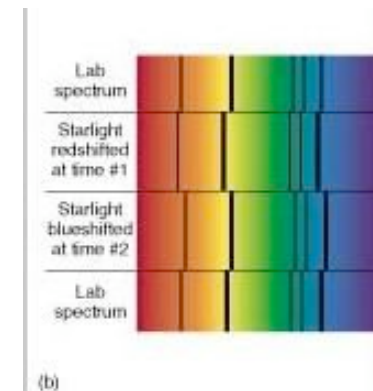
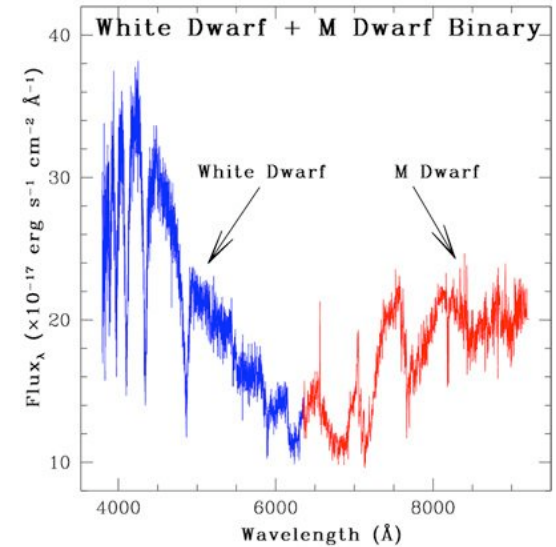


Reclaiming her other astronomical accomplishments

Of the seventeen stars designated as having the c-characteristic, “at least ten are variable or suspected variables” (DH, *Women in the History of Variable Star Astronomy*)

Of eighteen stars with the composite spectra designation, a 1989 catalog of spectroscopic binaries included fifteen and all but one are still considered composite spectra (DH, 2002)

“In a sampling of twenty stars that Maury had assigned to division b, fourteen are now known to be spectroscopic binaries” (DH, 1994)



1889 Pickering discovers Mizar (Zeta Ursa Majoris) is a spectroscopic binary

- ▶ Maury then confirms and calculates the period
 - ▶ Maury soon after discovers the second known spectroscopic binary, Beta Aurigae
 - ▶ In an updated study (1898), Maury calculates the period and masses.
- Upon returning to HCO, spectroscopic binaries became her chief interest (under the mentorship of Harlow Shapley, who “understood and encouraged her” (DH 1980))



Among her accomplishments

- ▶ calculated orbits of eclipsing and spectroscopic binaries Mu-1Scorpii and V Puppis (1921) and explained peculiarities in spectra as due to stellar rotation
- ▶ published preliminary data on spectroscopic binary Upsilon Sagittarii (1921) and in a later paper (1925) refuted Ludendorff's 260 and 54 solar mass estimates for the system
- ▶ determined the orbit of spectroscopic binary Zeta Centauri (1922)
- ▶ demonstrated that the variable Beta Lupi is not a binary (as had been asserted) (1925)
- ▶ Assisted Luyten in a study of visual and spectroscopic binary Beta Capricorni by reexamining HCO plates and measuring the velocity variation of the secondary

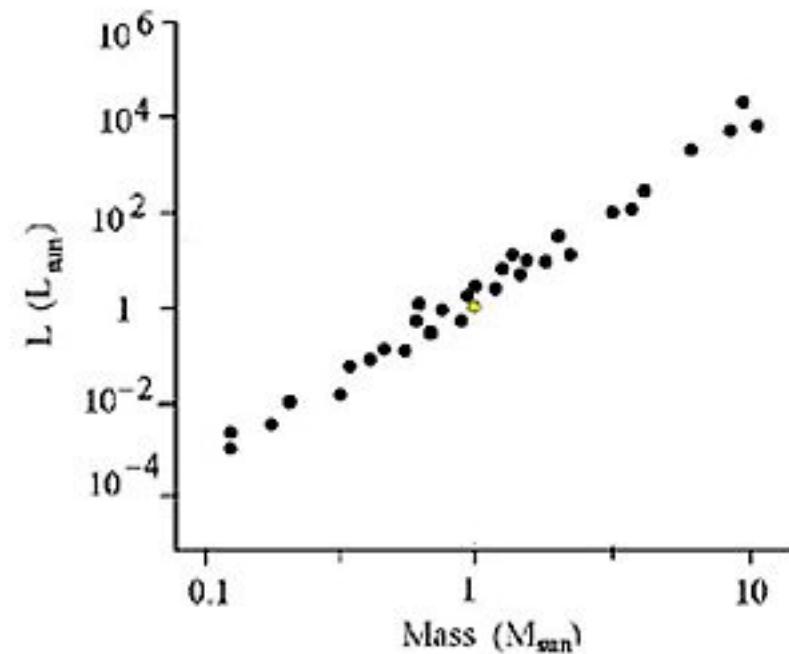


Her passion: the enigmatic Beta Lyrae

- ▶ Preliminary results presented at the Dartmouth meeting of the AAS (1924), extensive analysis published in 1933
- ▶ Suggested binary consisted of highly elongated stars surrounded by common (and complex) envelope
- ▶ Made the radical suggestion that the visible B9 primary was less massive than the unseen B5 secondary



As noted by B. Welther (1981-83), Maury's results were immediately questioned by F.J.M. Stratton and Otto Struve because her results violated Eddington's seemingly sacrosanct mass-luminosity relationship, which was thought to be valid for all stars "regardless of whether they are giants or dwarfs" (Eddington 1924)



“though more exact work along these lines will be possible with the application of modern photometric methods in securing future spectra, Miss Maury’s pioneer work will doubtless hold good in its broad outline” (Stratton 1934)

“Some ten years ago we might have doubted the mass-luminosity relation, but that avenue of escape no longer exists.... The evidence is so overwhelmingly against the B5 component that our hypothesis may now be regarded with some confidence” (Struve 1934)



“We are now prepared to form a physical picture of Beta Lyrae. There are two stars, one of which is of type B9.... This star is a giant.... The other star... must correspond to that of a star of class late A or early F.” (Struve 1941)



“perhaps Maury got stuck on too big a problem”
(Helen Sawyer-Hogg)

“She had a flair for picking out tremendous problems. If you look at the literature for Beta Lyrae you will see that nobody has ever solved the problem” (C P-G)

“I am tempted to say Beta Lyrae is battling with us like a twelve-headed dragon with a prince from fairy tales. As soon as one mystery is clarified, another one appears to continue the fight” (P. Harmanec 1992)



“It is interesting that after this [criticism] Miss Maury’s paper was quite forgotten and that is is never referred to in the more recent papers”
(S. Kriz, 1974)

Kriz (1974) proposed masses of 1 – 4 and 10 -14 solar masses, respectively, and summarized that
“Our conclusions clearly agree in the main feature with the original model of the Beta Lyrae, published by Miss Maury (1933).”

→ Maury was once again listed in Beta Lyrae bibliographies



How do we paint a complete picture of Antonia Maury, not just of her career, and place her, and it, into the greater context of astronomical history?

[the key may just be her little sister]



FIG. 51. Miss Antonia Caetano Maury, research associate, 1886-1933.





Carlotta Joaquina Maury (1874–1938)

- ▶ Both sisters were home schooled by parents who valued education and science
- ▶ Both sisters received quality baccalaureate educations (Antonia at Vassar, Carlotta at Radcliffe and Cornell)
- ▶ Both taught high school for a time
- ▶ Both were employed in sciences which at that time relegated women's work to tedious classification and discouraged hands-on field work for women (astronomy and geology/paleontology)
- ▶ Both went beyond this to theorize new relationships and explanations of observed phenomena



Antonia went to work at HCO right after completing her bachelors.

Carlotta continued on to graduate school, including the University of Paris, and received a Ph.D. in geology/paleontology from Cornell in 1902.





FIG. 51. Miss Antonia Cattano Maury, research associate, 1880-1933.

- ▶ @1891/2 – leaves HCO with project uncompleted
- ▶ 1891-1918 teaches high school on and off
- ▶ Returns briefly to HCO to complete project (1897)
- ▶ Finds some stability at HCO 1918-1935
- ▶ Publishes and presents results of various projects over several decades



- ▶ 1902 Completes Ph.D.
- ▶ 1904-6 Assistant at Columbia
- ▶ 1907-1909 Invited by Cornell advisor G.D. Harris to investigate oil-bearing sediments for the Louisiana Geological Survey
- ▶ 1909-1912 Assistant at Barnard and Columbia
- ▶ 1910-1 Recruited by noted oil geologist A.C. Veatch to act as paleontologist for his geological expedition to Venezuela and Trinidad. She discovers first evidence connecting Eocene geological strata of Caribbean to that of North and South America.
- ▶ 1912-5 Teaches at Huguenot College in South Africa
- ▶ 1916 Leads her own geological expedition to the Dominican Republic, despite the ongoing political revolution and invasion by American Marines.
- ▶ 1917 Publishes seminal study of the geology and paleontology of Dominican Republic (including 400 new species)
- ▶ 1912-1938 (death) Publishes in prestigious journals, solves geological and paleontological debates and mysteries, intermittently consults for the Brazilian government and Royal Dutch Shell Petroleum Company



The importance of mentors to women in science

Antonia found support in Harlow Shapley later in life, but seems to have lacked that vital connection in her early years.

“I remember Miss Maury saying to me, rather sadly, ‘I always wanted to learn the calculus, but Professor Pickering didn’t wish it’.”

- (C P-G)





Comparing standard biographical citations



“a dour and talented astronomer whose physical insights and boredom with drudgery did not well fit her for the routine work of spectral classification” (Dobson and Bracher 1992)

“an exceptionally able paleontologist. She had a reputation for being extremely efficient and energetic; if she accepted an assignment she proceeded with speed and precision” (Creese 2007)

“known to have a sparkling personality, to enjoy philosophical discussions, and to sprinkle her prolific writings with humor and poetic charm.”
(Carpenter 1995)



“The elegant Mrs. Draper already disliked her niece-in-law who dressed carelessly and did the work as she herself thought best, instead of dutifully, and without questioning....” (DH 2002)

“She is not a valuable member of the corps.... I shall be happy when you are rid of the annoyance.” (Anna Draper to Pickering, 1893)



FIG. 51. Miss Antonia Cattano Maury, research associate, 1880-1933.

My continued working hypothesis: We need to treat this as a tale of two sisters in two sciences. In doing so, we can continue to bring to light the contributions of both women and shed light on how societal (and familial) issues played important roles in shaping the careers of women in science.



FIG. 51. Miss Antonia Caetano Maury, research associate, 1886-1933.



This work is dedicated to
Dorrit Hoffleit, and her undying respect
for “Miss Maury”

