Bipolars edit log PhL 2.20.14

This little doc is already 37 pages long, so we need to start a log. It will go out on the web eventually.

Feb 20,2014.

It is still growing. Added sections showing how to compute the metric tensor and how it is a case of a conformal map. Both these required me to review the relevant topics.

Feb 21,2014.

Installed stuff about conformal mapping, I think the content is now done, but I have to pick up some items promised in earlier sections:

why are the circles in fact circles??
the inverse transformation equations??

OK, I did both these things in Section 14. Perhaps now I am done and it only needs cleanup. This baby is now about 50 pages long. My main interest really was to get that $n(\theta)$ charge distribution and indeed I obtained it and can perhaps use it to deal with my new major problem in lines doc, as outlined there in the edit log.

Feb 22,2014.

Add section comparing different author's versions of the bipolar coordinates.

I am now doing a general proofing, checking everything including equation numbers.

I just went through the entire doc adjusting position of equation numbers, all done.

Section 1 OK
Section 2 OK
Section 3 OK, all this stuff I think is very good.
Section 4 OK
Section 5 OK
Section 6 OK
Section 7 OK after a lot of repair work, and now showing the graph code.
Section 8 OK, did various edits.
Section 9 OK (now).
Section 10
(a) OK
(b) OK
(c) OK
(d) OK this is a long Section, hence goes into the paper title.
Section 11
(a) OK

(b) OK
(c) OK

Section 12

OK and very good and concise I think

Section 13

(a) OK
(b) OK
(c) OK
(d) OK

Section 14

(a) OK
(b) OK

That was a full proofing. I would like to add a final section showing the connection to other well-known authors on this subject, then it is done (add references and a short intro as well.)

Sun Feb 23,2014.

I spent the whole morning doing two things

(1) seeing how other authors deal with bipolar coordinates

(2) while doing this, I found on wiki a better way to do the bipolar map to avoid the u→-u unpleasantry. Things are much better now.

The afternoon then went writing the last section on "other sources" which took a lot of work.

I still have to do the References. // Done. I then added a 1-page Summary (no Overview needed with such a short summary). I then inserted section breaks. It is shaping up finally, no PDF yet.

Mon Feb 24,2014.

I want to proof sections that I changed or are new.

Summary: OK, all on one page, I think always good to have a little executive summary so people don't have to pore over the paper looking for something that is not there. θ r labels a circle, θ labels a ray

Section 1 -- just did a rewrite.
Section 2 -- more rewriting with figure improvements!
Section 3 -- OK, various edits
Section 4 -- good
Section 5 -- fine
Section 6 -- OK
Section 7 -- I think my θ/u plot is completely wrong, horrors! No, but I did make is cleaner, all OK.
Section 8 review is in progress many changes being made! OK finally at 3 PM.
Section 9

OK, I did read through Section 14 and looked at the References, I am burned out on proofing.

Did a little more hit and miss proofing, then did pagination which was pretty fast, then did first PDF. Bookmarks are all OK.

Errata:

* I just added the title into Properties of the doc.
* did a zillion little equals sign centerings.

Second PDF. OK

Spell check? Short enough to mark all, just did a scan, saw no problems.

Let's do a release just to get the spider on it!

Tues Feb 25, 2014.

I did not like my overview paragraph and changed it. Then I proofed the PDF from the start through Section 12, making maybe 15 small changes. I ran out of steam at that point, so will make a new PDF release of today's date and put in out on the web. Expanded overview to 2 pages by adding blank lines, it was just too dense. Release done!

Next, I want to clean up the files and make indices as needed. // Reviewed all docs, and made separate Maple and Visio indices, I am now done for the moment with this bipolar doc project at 10 AM.

Sat Mar 8, 2014.

I have some notational changes to make which keep confusing me every time I look at bipolar doc, so let's get this done. It has to do with n, dn, q, dQ and all that stuff. // It is done with today's date. Will not re-release quite yet, want to "use" it a little!

Sun Mar 9, 2014.

I think I added Appendix A on this date, but did not make a new PDF.

Sat Aug 2, 2014.

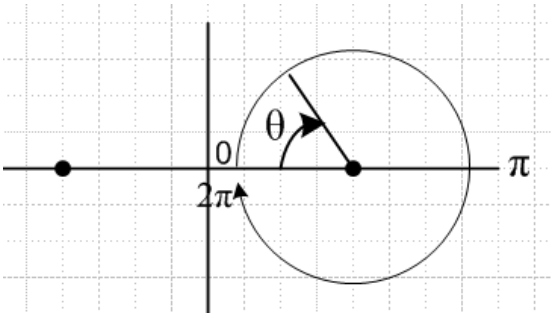
I just released lines doc and I now want to release my updated version of bipolar doc. I will first see if there are any errata pending. It says to repaginate, so I will do that right now, that was only errata. Note that Appendix A has been added and some n and Q charge dimension things were changed. I did some browsing, did the pagination, made a new PDF, and did the local release.

March 1, 2015.

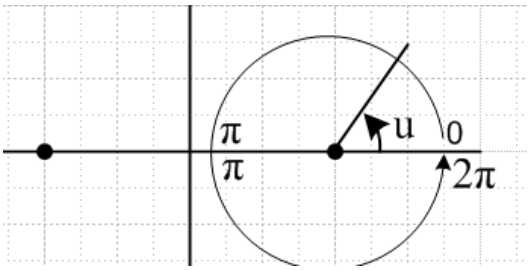
I got an email from **John Boyd** who wants to reference my paper. So today I scanned for errata and fixed various things, all cosmetic except a few minor added words and comment on GR8 at the end.

I then started reading his PDF and it made me look at M&F page 1210 which I quote in my Section 15, but my M&F picture looks wrong in terms of the angle M&F call θ. So let's study this here.

On page 1210 M&F have their famous bipolar picture, and here is what it really shows for angle θ



This is the M&F θ



This is the PhL u

So my bipolar doc picture showing their θ is wrong! And my equations are then also wrong.

Given the correct two pictures above, how are u and θ related??

θ	u
0	π
π/4	3π/4
π/2	π/2
3π/4	π/4
π-ε	0
π+ε	2π
π+π/4	2π-π/4
2π	π

Here is the solution, as I have now done on scratch

$u = \pi - \theta \qquad 0 \le \theta < \pi$
$u = 3\pi - \theta \qquad \pi < \theta \le 2\pi$

What does this mean for trig functions? These results are the same with the π or the 3π

$\sin(u) = \sin(\pi-\theta) = \sin(\theta)$
$\cos(u) = \cos(\pi-\theta) = -\cos(\theta)$
$\tan(u) = -\tan(\theta)$
$du = -d\theta$
$\hat{\mathbf{u}} = -\hat{\boldsymbol{\theta}}$
$B_u = -B_\theta$
$\partial_u B_u = \partial_\theta B_\theta$

Ouch!!!! This then differ from what I had in bipolar doc. Lets translate some equations now:

$x = a\,sh\xi/(ch\xi + \cos\theta)$ (2.2)
$y = a \sin\theta/(ch\xi + \cos\theta)$ OK

$(x - x_c)^2 + y^2 = R^2$ $x_c = a/th\xi$ $R = a/|sh\xi|$ (2.4)
no change

$x^2 + (y- y_c)^2 = R^2$ $y_c = - a /\tan\theta$ $R = a/|\sin\theta|$. (2.6)

$\theta = - \tan^{-1}[\, 2ay/(x^2+y^2- a^2)]$. (4.1)

$h_\xi = h_\theta = a/(ch\xi+\cos\theta) \equiv h$. (3.3)

$[\text{div } \mathbf{B}](\mathbf{x}) = (1/a) \{ (ch\xi–\cos u) (\partial_\xi B_\xi + \partial_u B_u) - sh\xi\, B_\xi - \sin u\, B_u \}$. (8.14)

$[\text{div } \mathbf{B}](\mathbf{x}) = (1/a) \{ (ch\xi+\cos\theta) (\partial_\xi B_\xi + \partial_\theta B_\theta) - sh\xi\, B_\xi + \sin\theta\, B_\theta \}$

$$[\text{grad } f](\mathbf{x}) = (1/a) (ch\xi - \cos u) \left[\frac{\partial f(\xi,u)}{\partial \xi} \hat{\boldsymbol{\xi}} + \frac{\partial f(\xi,u)}{\partial u} \hat{\mathbf{u}} \right] . \quad (8.19)$$

$$[\text{grad } f](\mathbf{x}) = (1/a) (ch\xi+ \cos\theta) \left[\frac{\partial f(\xi,u)}{\partial \xi} \hat{\boldsymbol{\xi}} + \frac{\partial f(\xi,\theta)}{\partial \theta} \hat{\boldsymbol{\theta}} \right] . \quad (8.19)$$

$$[\nabla^2 f](\mathbf{x}) = (1/a^2) (ch\xi–\cos u)^2 \left(\frac{\partial^2 f(\xi,u)}{\partial \xi^2} + \frac{\partial^2 f(\xi,u)}{\partial u^2} \right) . \quad (8.22)$$

$$[\nabla^2 f](\mathbf{x}) = (1/a^2) (ch\xi+\cos\theta)^2 \left(\frac{\partial^2 f(\xi,u)}{\partial \xi^2} + \frac{\partial^2 f(\xi,\theta)}{\partial \theta^2} \right) . \quad \text{OK} \quad (8.22)$$

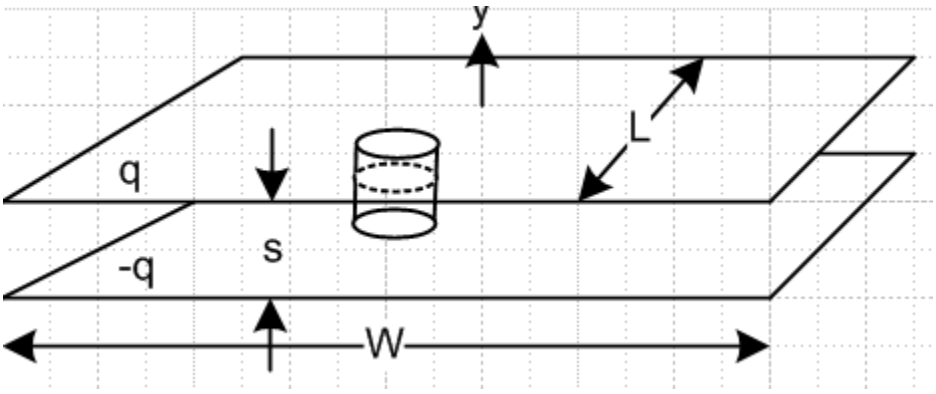
OK, it is now 4 PM and I am done with this edit pass. I found that I had done M&F wrong and Lebedev wrong, so Section 15 is very much rewritten. The overall doc is now better.

Pagination redo please:

opening stuff: OK, no change
Section 1: OK
Section 2: OK
Section 3: OK
Section 4: OK
Section 5: OK
Section 6: OK
Section 7: OK
Section 8: OK
Section 9: OK
Section 10: OK
Section 11: OK
Section 12: OK

Pause. I am confused about my parallel plate capacitor in Section 13. It makes no sense. I took quite a while to rewrite this, below are some of the elements.

Parallel Plate Capacitor.



Assume the upper plate has total charge Q so the surface charge density is $\sigma = Q/\text{area} = Q/(WL)$.
Gaussian pillbox shown has end area dA and captures charge σdA. The E field between the plates points down since upper plate is positive, so $\mathbf{E} = -E\,\hat{\mathbf{y}}$ where $E > 0$. The E field outside the plates is 0.

Then Gauss's Law says

$$(1/\varepsilon)\int_V \rho\, dV = \int_S \mathbf{E}\bullet d\mathbf{S}$$

$$(1/\varepsilon)\,\sigma\, dA = (-E\,\hat{\mathbf{y}})\bullet(-\hat{\mathbf{y}}\, dA) = EdA \quad \Rightarrow \quad E = \sigma/\varepsilon$$

The potential between the plates is

$$\varphi(y_{top}) - \varphi(y_{bot}) = -\int_{y_{bot}}^{y_{tob}} \mathbf{E}\bullet d\mathbf{y} = -\int_{y_{bot}}^{y_{tob}} (-E\,\hat{\mathbf{y}})\bullet(dy\,\hat{\mathbf{y}}) = E(y_{top}-y_{bot}) = Es$$

$$V = Es = (\sigma/\varepsilon)s = ([Q/(WL)]/\varepsilon)s = Q\,s/(\varepsilon WL) \quad \Rightarrow$$

Q = CV so C = Q/V = = (εWL/s

$$C = \varepsilon\,\text{Area/Separation} = \varepsilon\frac{A}{s} \qquad A = \text{area} \qquad s = \text{plate separation}$$

Now apply this to our picture

$$A = 2\pi * L \qquad s = \xi_2 - \xi_1$$

Then

$$C = \varepsilon \frac{A}{s} = \varepsilon \frac{2\pi * L}{\xi_2 - \xi_1}$$

Letting C be the capacitance per unit length of the parallel place capacitor, we get

$$C = \frac{2\pi\varepsilon}{\xi_2 - \xi_1}$$

March 2, 2015.

Continuing with this update round. Start proofing with Section 13.

Section 13: OK
Section 14: OK
Section 15: OK
Appendix A: OK
References: OK

[3] P. Lucht, *Tensor Analysis and Curvilinear Coordinates* (2014), http://user.xmission.com/~rimrock. If not there, search on "Phil Lucht Documents".

I won't change my references, like having the pixel thing to block search from finding my self-references.

I just went through and centered all the pictures.

Now at 10:15 AM I will try a PDF.

I got the PDF made, updated my website, and put the thing on researchgate (see researchgate.doc). That caused it to have a DOI which is 10.13140/2.1.2536.7842 . My first ever paper with a DOI.

June 15, 2015

I noted a large error while reading this last time. So I will proof the thing again, fix this error, and fix anything else I note, then update the web in both places!! But I will start deep in the paper where I usually get glazed and do that first.

Proofing

Section 13
(a) OK and I fixed the big error
(b) OK
(c) OK .
(d) OK I had a large number of bad equation numbers here!!!! All fixed now

Section 14
(a) OK

(b) OK
(c) OK // was missing as a heading!! \

Section 15
(a) OK
(b) OK
(c) OK

Appendix A OK

References OK

I found way too many bad equation numbers. Makes me thing maybe I should proof other sections. Maybe start with the hard sections which I probably just scanned on recent proofing passes:

Section 10 this is difficult proofing, there are many cross references. No errors really, usual cosmetic changes. .
(a) OK
(b) OK
(c) OK
(d) OK

Section 11 did a quick read through, seems OK

Section 12 did a quick read through, seems OK

Now back up and do Section 9

Section 9 OK

Enough. I have recently read from the start through Section 8, so I think things are "uniformly proofed" in this paper.

This thing is headed out the door. PDF release June 15, 2015. Done and on my site.
Have a duplicate file Bipolare.pdf due to Boyd thing.

[49] P. Lucht, Bipolar coordinates and the two-cylinder capacitator, available at http://user.xmission.com/~rimrock/Documents/Bipolare, 71 pp.

I checked that the path works, you have to capitalize Documents, but cap on bipolare,pdf does not matter.

See RG notes from here on concerning how I got the RG paper updated.