

Jewish Geometry
Adam Simon Levine
NHC Summer Institute 2018

Part III: The Great Circle Route Toward Jerusalem

1. I Kings 8:44-49

כי-יצא עמך למלחמה על-איבו בדרך אשר תשליחם; והתפללו אל-יהוה דרך העיר אשר בחרת בה והבית אשר-
בנתי לשמך. ושמעת השמים את-תפלתם ואת-תחנונתם; ועשית משפטם. כי יקטאו-לך, כי אין אדם אשר לא-
יקטא ואנפת בם ונתתם לפני אויב; ושכום שביהם אל-ארץ האויב, רחוקה או קרובה. והשיבו אל-לכם בארץ
אשר נשבו-שם; ושבו והתחנונו אליה בארץ שביהם לאמר, חטאנו והעוינו, רשענו. ושבו אליה בכל-לכם
ובכל-נפשם בארץ איביהם, אשר-שבו אתם; והתפללו אליה דרך ארצם אשר נתתה לאבותם, העיר אשר
בחרת, והבית אשר-בנית (בניתי) לשמך. ושמעת השמים מכון שבתך את-תפלתם ואת-תחנונתם; ועשית
משפטם.

If Your people go out to battle against their enemy, by whatever way You shall send them, and **they pray to the LORD toward the city which You have chosen**, and toward the house which I have built for Your name, then may You in heaven hear their prayer and their supplication, and maintain their cause. If they sin against You — for there is no one who does not sin — and You become angry with them and deliver them to the enemy, so that they carry them away captive to the enemy's land, far off or near; yet if they shall repent in the land where they are captive, and turn back, and make supplication to You in the land of them that carried them captive, saying: “We have sinned, and have done iniquitously, we have dealt wickedly;” if they return unto You with all their heart and with all their soul in the land of their enemies, who carried them captive, **and pray to You toward their land**, which You gave to their fathers, the city which You have chosen, and the house which I have built for Your name; then hear their prayer and their supplication in heaven Your dwelling-place, and maintain their cause.

2. Daniel 6:11

וַדַּנְיָאֵל כְּדִי יָדַע דֵּי רְשִׁים כְּתָבָא עַל לְבִיתָהּ וְכוּיָן פְּתִיחֹן לָהּ בְּעֵלְיִתָהּ נִגְדַּד יְרוּשָׁלַם וְזִמְנִין תְּלַתָּהּ בְּיוֹמָא הוּא בָרַךְ
עַל בְּרַכּוּהִי וּמְצַלָּא וּמוֹדָא גְדָם אֱלֹהֵהּ כֹּל קַבְּלֵי דֵּי הָנָא עֲבָד מִן קֳדָמַת דְּנָה:

And when Daniel knew that the edict was signed, he went into his house — **now his windows in his upper chamber opened toward Jerusalem** — and he knelt upon his knees three times a day, and prayed, and gave thanks before his God, as he had done previously.

3. Babylonian Talmud, Berachot 30a

תנו רבנן סומא ומי שאינו יכול לכוין את הרוחות יכוין לבו כנגד אביו שבשמים שנאמר +מלכים א' ח'+
והתפללו אל ה' היה עומד בחוץ לארץ יכוין את לבו כנגד ארץ ישראל שנאמר +מלכים א' ח'+ והתפללו אליך

דרך ארצם. היה עומד בארץ ישראל יכוין את לבו כנגד ירושלים שנאמר +מלכים א' ח' + והתפללו אל ה' דרך העיר אשר בחרת. היה עומד בירושלים יכוין את לבו כנגד בית המקדש שנאמר +דברי הימים ב' ו' + והתפללו אל הבית הזה. היה עומד בבית המקדש יכוין את לבו כנגד בית קדשי הקדשים שנאמר +מלכים א' ח' + והתפללו אל המקום הזה. היה עומד בבית קדשי הקדשים יכוין את לבו כנגד בית הכפורת היה עומד אחורי בית הכפורת יראה עצמו כאילו לפני הכפורת. נמצא עומד במזרח מחזיר פניו למערב במערב מחזיר פניו למזרח בדרום מחזיר פניו לצפון בצפון מחזיר פניו לדרום. נמצאו כל ישראל מכוונים את לבם למקום אחד אמר רבי אבין ואיתימא רבי אבינא מאי קראה +שיר השירים ד' + כמגדל דויד צוארך בנוי לתלפיות תל שכל פיות פונים בו.

Our sages taught: A blind person, or a person who cannot determine the directions, directs their heart toward their Father in heaven, as it is written (I Kings 8:44): “And they pray to the LORD.” One who is outside of Israel directs their heart toward the land of Israel, as it is written (I Kings 8:48): “And they shall pray to You, toward their land.” One who is in the land of Israel directs their heart toward Jerusalem, as it is written (I Kings 8:44): “And they shall pray toward the city that You have chosen.” One who is in Jerusalem directs their heart toward the Temple, as it is written (II Chronicles 6:32): “And they shall pray toward this house.” One who is in the Temple directs their heart toward the Holy of Holies, as it is written (I Kings 8:44): “And they shall pray toward this place.” ... Thus, one who is in the east faces west, one who is in the west faces east, one who is in the south faces north, and one who is in the north faces south. We find all of Israel directing their hearts to a single place. R. Avin (some say, R. Avina) says: What verse supports this? (Song of Songs 4:4) “Your neck is like the tower of David, built with shields (*talpiyot*)” — a hill (*tel*) to which all mouths (*piyot*) turn.

4. Babylonian Talmud, Bava Batra 25a-b

ת"ש דתניא ר"ע אומר לכל רוח הוא עושה ומרחיק חמשים אמה חוץ ממערבה דאינו עושה כל עיקר מפני שהיא תדירא. א"ל רבא לרב נחמן מאי תדירא? ... תדירא בשכינה דאריב"ל בואו ונחזיק טובה לאבותינו שהודיעו מקום תפלה דכתיב +נחמיה ט' + וצבא השמים לך משתחוים. מתקיף לה רב אחא בר יעקב: ודלמא כעבד שנוטל פרס מרבו וחוזר לאחוריו ומשתחוה! קשיא. ... ואף רב ששת סבר שכינה בכל מקום דא"ל רב ששת לשמעיה לכל רוחתא אוקמן לבד ממזרח, ולא משום דלית ביה שכינה אלא משום דמורו בה מיני. ... אמר רבי יצחק הרוצה שיחכים ידרים ושיעשיר יצפין וסימניך שלחן בצפון ומנורה בדרום. ורבי יהושע בן לוי אמר לעולם ידרים שמתוך שמתחכם מתעשר שנאמר +משלי ג' + אורך ימים בימינה בשמאלה עושר וכבוד. והא רבי יהושע בן לוי אמר שכינה במערב! דמצדד אצדודי. אמר ליה רבי חנינא לרב אשי כגון אתון דיתביתו בצפונה דא"י אדרימו אדרומי. ומנא לך דבבל לצפונה דארץ ישראל קיימא דכתיב +ירמיהו א' + מצפון תפתח הרעה על כל יושבי הארץ.

R. Akiva says: [A tannery] may be set on any side at a distance of fifty cubits, save on the west side, where it must not be placed at all, because it is a constant abode. Said Raba to R. Nahman: A constant abode of what? ... It is the constant abode of the Shechinah. For so said R. Joshua b. Levi: Let us be grateful to our ancestors for showing us the place of prayer, as it is written (Nehemiah 9:6): “And the host of heaven worships You.” R. Aha bar Jacob strongly objected to this [interpretation]: Perhaps [the sun and moon bow down to the east], like a servant who has received a gratuity from his master and retires backwards, bowing as he goes! This is a difficulty. ... R. Shesheth [who was

blind] also held that the Shechinah is in all places, because [when desiring to pray] he used to say to his attendant: “Set me facing any way except the east.” And this was not because the Shechinah is not there, but because the heretics require turning to the east. ... R. Isaac said: One who wishes become wise should turn to the south, and one who wishes to become rich should turn to the north. The mnemonic is that the table [in the Tabernacle] was to the north of the altar and the candlestick to the south. R. Joshua b. Levi, however, said that one should always turn to the south, because through obtaining wisdom one will obtain wealth, as it says (Proverbs 3:16): “Length of days are in her [wisdom’s] right hand, in her left hand are riches and honor.” But was it not R. Joshua b. Levi who said that the Shechinah is in the west? — [He means that] one should turn partly to the south.

R. Hanina said to R. Ashi: Those like you who live to the north of Eretz Yisrael should turn to the south. How do we know that Babylon is to the north of Eretz Yisrael? — From the scriptural verse, (Jeremiah 1:14) “Out of the north evil shall break forth upon all the inhabitants of the land.”

5. Marcus Vitruvius Pollio, *De Architectura* IV.5 (c. 70 BCE – c. 15 BC, Rome)

If there be nothing to prevent it, and the use of the edifice allow it, the temples of the immortal gods should have such an aspect, that the statue in the cell may have its face towards the west, so that those who enter to sacrifice, or to make offerings, may have their faces to the east as well as to the statue in the temple. Thus suppliants, and those performing their vows, seem to have the temple, the east, and the deity, as it were, looking on them at the same moment. Hence all altars of the gods should be placed towards the east.

But if the nature of the place do not permit this, the temple is to be turned as much as possible, so that the greater part of the city may be seen from it. Moreover, if temples be built on the banks of a river, as those in Egypt on the Nile, they should face the river. So, also, if temples of the gods be erected on the road side, they should be placed in such a manner that those passing by may look towards them, and make their obeisance.

6. Tur, Orach Chayim 94 (R. Jacob ben Asher, 1269–1343, Germany)

וכהך שמעתתא קיימא לן ולא כההיא דב"ב דפליגי אמוראי בפרק לא יחפור איכא מ"ד שכינה במזרח וצריך להחזיר פניו למזרח ואיכא מ"ד שכינה במערב וצריך להחזיר פניו למערב. ואנן שמחזירין פנינו למזרח מפני שאנו יושבים במערבה של ארץ ישראל וכשנחזיר פנינו למזרח נמצינו מתפללין כנגד ירושלים.

We hold by this ruling [Berachot 30a] and not by that of Bava Batra, where some Amoraim say that the Shechinah is in the east and therefore one must face east, and some say that the Shechinah is in the west and therefore one must face west. We face east because we live west of Israel, and when we face east, we thus pray toward Jerusalem.

7. Shulchan Aruch, Orach Chayim 94:1-3 (R. Joseph Caro, 1488–1575, Israel)

בקומו להתפלל, אם היה עומד בח"ל, יחזיר פניו כנגד ארץ ישראל ויכוין גם לירושלים ולמקדש ולבית קדשי הקדשים; היה עומד בא"י, יחזיר פניו כנגד ירושלים ויכוין גם למקדש ולבית קה"ק; היה עומד בירושלים, יחזיר פניו למקדש ויכוין ג"כ לבית קדשי הקדשים; היה עומד אחורי הכפורת, מחזיר פניו לכפורת. אם מתפלל לרוח משאר רוחות, יצדד פניו לצד א"י אם הוא בח"ל; ולירושלים, אם הוא בא"י; ולמקדש, אם הוא בירושלים. הגה: ואנו שמחזירין פנינו למזרח, מפני שאנו יושבים במערבה של א"י, ונמצא פנינו לא"י (טור וסמ"ג). אין עושין מקום הארון וצד התפלה נגד זריחת השמש ממש, כי זהו דרך המינים, רק מכוונים נגד אמצע היום (הגהות אלפסי החדשים). ומי שרוצה לקיים אמרם: הרוצה להעשיר יצפין או להחכים ידרים, מכל מקום יצדד פניו למזרח. מי שאינו יכול לכוין הרוחות, יכוין לבו לאביו שבשמים.

When getting up to pray, one who is standing outside of Israel faces toward Israel and also directs toward Jerusalem, the Temple, and the Holy of Holies. One who is standing in Israel faces toward Jerusalem and directs toward the Temple and the Holy of Holies. One who is standing in Jerusalem turns toward the Temple and directs toward the Holy of Holies. ...

If one is praying in a different direction, one turns one's face toward Israel (if outside Israel), toward Jerusalem (if in Israel), toward the Temple (if in Jerusalem). *Rema* (R. Moses Isserles, 1520–1572, Poland): *We face east because we live west of Israel, and when we face east, we thus pray toward Jerusalem. We do not build the ark and the side for prayer facing due east, for that is the way of the heretics, but rather turn slightly to the south. And even one who wishes to fulfill the expression, "One who wishes become wise should turn to the south, and one who wishes to become rich should turn to the north," should nevertheless turn his face to the east.*

One who does not know how to determine the direction should turn their heart to their Father in heaven.

8. Levush, Orach Chayim 94 (R. Mordecai ben Avraham Yoffe, 1530–1612, Poland)

And we, who turn to the east, should not face due east; on the contrary, one who does this is completely wrong, for that is the practice of the heretics who pray to the location of sunrise, and their intention is to bow to the sun and make it a god, *chas v'shalom*. Rather, because we live west of Israel, when we turn to the east, we find ourselves facing toward Israel, Jerusalem, the Temple, and the Holy of Holies. Note that the lands where we are scattered are all to the northwest of Israel, not directly west of Israel, and [knowledge of] the length of days and nights will make this clear to anyone who knows about the shape of the earth. Therefore, I believe it is proper that when building a synagogue, that the eastern wall in which the ark is built and towards which we pray should be turned slightly toward the southeast. Thus, we will stand facing Israel, Jerusalem, the Temple, and the Holy of Holies, and we will not imitate the heretics who claim that we face the sun like them.

But setting up the synagogue in these places requires some consideration. In summary, by studying the globe, it is clear to me that we should set it up as follows. On the day of the equinox (plus or minus six or seven days), when the sun rises in the

morning and enters the window in the middle of the eastern wall of the synagogue and the beam strikes the western wall, the beam starts at a point far south of the middle and reaches the middle of the wall after half an hour or an hour. A synagogue built like this, in these places, truly faces Jerusalem and the Temple according to the globe [approx. 5-10° south of east]. But if we set it up such that on the aforementioned days, the beam strikes the middle of the western wall immediately at sunrise, then it is facing due east, and that is the practice of the heretics. If we were to do this, we would be copying the heretics and not bowing toward Jerusalem and the Temple, and thus we should not build a synagogue in this manner. And if we build it so that the sunbeam strikes the western wall north of the middle, even though this synagogue does not imitate the heretics, it is nevertheless not built in accordance with the verse “They shall pray ... toward their land,” for it does not face Jerusalem or the Holy of Holies, but rather turns away from them, and this is the third figure that I drew. And even though the Sages say, “To become rich, turn north; to become wise, turn south,” nevertheless one should always face toward Jerusalem, because the Bible says “Pray toward their land,” and according to the first picture that I drew, everyone on earth will come to the right conclusion, I believe.

9. Emunat Chachamim (R. Aviad Sar Shalom Basilea, 1680–1749, Italy)

In Germany and Poland, and also in Italy, the Levush is correct that the wall should face a bit to the south. But the Levush’s reasoning is incorrect, with all due respect. There are places that satisfy the same conditions that the Levush mentioned [i.e., their latitude is greater than that of Israel], yet one who wants to face toward Israel precisely should turn slightly to the north. The idea is not to look at north in the world and south in the world, measured with respect to the equator, but rather north and south of the city. The most important great circle that passes through the city, known in their language as *verticale primario*, is what you need to know if you want to determine whether to turn to the north or the south in order to face Israel. It is impossible to understand this if you don’t know trigonometry, so I have skipped the details here. In the end of the book, I will explain all of this in a foreign tongue [Italian] so those who are familiar with this subject can know what direction a person should pray, although we really don’t need such precision. I have illustrated this with the example of Lisbon, the capital of the kingdom of Portugal, which is 39.5° north of the equator, whereas Jerusalem is only 32° north. Thus, according to the Levush, someone in Lisbon should turn slightly south in prayer, but in fact it’s the opposite: the eastern wall should face slightly north.

10. Netzach Yisrael (R. Israel ben Moses Segal of Zamość, c. 1700–1772, Poland)

With all due respect to His Honor [the Levush], I will show that he has made a big mistake in his ruling that those who are northwest of Israel (i.e., whose latitude is greater than that of Israel), should face southeast. This is completely incorrect. After a brief introduction to the study of *hagrofia* (the measurement of the earth and its geometry), we will show that those who live due west of Israel should turn slightly north.

And as for those who live northwest of Israel, we shall find an exception to the rule given by the Levush, who thinks that the only factor that matters is latitude. Indeed, the answer also depends on how far west one's country is relative to Israel...

To figure out which way the ark should face, we need to know our latitude from the equator and our longitude from the west. [The prime meridian here is what we would call 31° W, dividing between the Old and New Worlds.] Subtract the longitude from 66° [the longitude of Jerusalem], and look up its cosine. Also look up the tangent of 32° [the latitude of Jerusalem] and the tangent of our latitude. If the cosine of the longitude difference times the tangent of the latitude is greater than the tangent of 32°, then we should turn a bit south when we face east. If this number is equal to the tangent of 32°, we should face due east. And if it's less than the tangent of 32°, we see clearly that we should turn a bit north when we face east. And all of these things are completely clear, without a doubt, and impossible to refute.

11. Shulchan Aruch HaRav, Orach Chaim 94:2 (R. Shneur Zalman of Liadi, 1745–1812, Belarus)

במקומות שנוהגים להתפלל לרוח משאר רוחות עכ"פ יצדד פניו לצד ארץ ישראל אם הוא בחוץ לארץ ולירושלים אם הוא בארץ ישראל ולמקדש אם הוא בירושלים. ואנו מחזירין פנים למזרח מפני שאנו יושבין במערבו של ארץ ישראל ונמצא פנינו לארץ ישראל ולכן קובעים ארון הקודש במזרח. ואפילו קבעוהו לצד אחר יתפללו לצד מזרח.

ומכל מקום מדינות אלו שהן לצד צפון הרבה אע"פ שהן במערבו של ארץ ישראל לא יקבעו מקום הארון וצד התפלה דהיינו כותל מזרחי כנגד אמצעית רוח מזרחית שלהם אלא כנגד מזרחית דרומית (קצת כפי ערך נטיית נקודת אמצע מזרח שלהם מכנגד ירושלים ונקודה זו הוא מקום יציאת שמש לעיר זו בתקופת ניסן ותשרי האמיתית והוא מקום פגישת גלגל משה היום באופק עיר זה שלכן היום והלילה שוים שם בתקופת ניסן ותשרי).

ומקום זה בכל מדינות אלו הוא להלאה מנקודת נוכח הראש של ירושלים וצריך לחשוב כמה יהיה כנגד ירושלים ברוחב שמגלגל משה היום עד רובע עגול שמנוכח הראש שלנו עד מקום פגישת האופק שלנו במשנה היום. ואם רוחב זה שמעגול זה עד משה היום כנגד ירושלים הוא יותר מרוחב שממשה היום עד נוכח הראש של ירושלים צריך לצדד קצת לדרום כפי ערך יתרון הזה ואם הוא פחות מזה צריך לצדד לצפון קצת ודבר זה תלוי במרחק המדינה מים המערבי כלפי המזרח ובהרחקה מטבור הארץ כלפי צפון יותר ממרחק ירושלים וחשבון זה קל להיודעים דרכי החשבון במשולש כדורי:

In places where the custom is to pray in another direction, one should nevertheless turn his face toward Israel if he is outside the land, toward Jerusalem if he is in Israel, and toward the Temple if he is in Jerusalem. And we turn to the east because we live to the west of Israel, so we face toward Israel, and therefore we build the ark in the eastern wall. Even if it is built in another wall, one should pray facing east.

Nevertheless, in places that are far north, even though they are to the west of Israel, the ark is not built facing due east, but rather southeast (according to how great the difference is between the due east point and the direction of Jerusalem).

This point is beyond the zenith point of Jerusalem. And you need to know the distance, along the meridian of Jerusalem, from the equator to the quarter-circle that goes from our location to the point where our horizon meets the equator. If this distance is

greater than the latitude of Jerusalem, one must turn to the south, according to the amount of the difference. And if it is less, one must turn a bit to the north. And this depends on the distance of our country from the western sea [i.e., its longitude], and its difference in longitude from the navel of the world [Jerusalem]. This computation is easy for those who know spherical trigonometry.

12. Aruch HaShulchan, Orach Chayim 94 (R. Yechiel Michel Epstein, 1829–1908, Russia/Lithuania)

Those earlier rabbis' [Tosafot, Tur, et al.] positions [that we live in the west and therefore face east] makes sense, since they were located in France and Germany, which are significantly to the west of Israel. But for Rema (who was in Poland) and here in Russia, in the northernmost parts of the world, we are really northwest of Israel, so when we face east, we're not really facing Israel! And great scholars [e.g. Levush] have dealt with this, and said that when one builds a synagogue, one should build the wall with the ark to face southeast, so that we will be facing Israel and Jerusalem. (Often it isn't possible to build as we would like, since constructions require government permission.)

...

However, most of the Jewish community does not do this: they build facing east and stand facing due east. And it seems to me that one can find justification for their practice... I would argue that the sages from Bava Batra do not really disagree with those from Berachot, and they all accept the obligation to face Israel and Jerusalem. ... In light of all of this, the obligation to stand "toward" Jerusalem doesn't mean "toward" per se, but just a slight turning in that direction. And I would argue that this comes from the language of the Baraita: "One directs their heart toward Israel / toward Jerusalem." Why doesn't it say "One stands facing Israel"? ...

According to this view that standing facing exactly toward Israel isn't required, our custom of facing east despite being northeast of Israel makes sense. Even though we are in the northwest, it is still slightly to the west. Standing facing only slightly toward Israel is no worse than only turning our faces, since the essence of the commandment is really to direct one's heart toward Israel. And since we are standing in the west and directing our hearts toward Israel, we are [sufficiently] turning toward Israel as well (since we're not due north, but rather north and slightly west). And similarly, if one were to the east of Jerusalem, one can turn west from anywhere [north or south] since that's where Israel is located.

13. Rabbi Howard Cohen, personal e-mail (Congregation Or HaTzafon, Fairbanks, Alaska)

Hi Adam,

Interesting question you ask. It falls under the category of questions like how does one truly observe Shabbat up here when the sun doesn't set or because three stars can't be seen for weeks and weeks on end. Since facing east is purely a symbolic gesture it is not necessary to determine in any literal or astronomical sense whether or not we are actually

turned towards Jerusalem. In other words, we symbolically face east like most Jews everywhere who locate themselves west of Jerusalem.

However, were this community more traditional I could imagine some people arguing for facing more towards Jerusalem. If I were to imagine walking from here to Jerusalem in as straight a line as possible I would think I would walk in a southeasterly direction toward some point on the east coast and then just continue heading east, southeast.

So although the math might suggest one of the two directions you mention intuition (rightly or wrongly) suggests one face southeasterly.

L'shalom,
Howard